UNIVERSITY OF ILLINOIS BULLETIN

ISSUED WEEKLY

Vol. XVI November 25, 1918 No. 13

[Entered as second-class matter December 11, 1912, at the post office at Urbana Illinois, under the Act of August 24, 1912. Acceptance for mailing at the special rate of postage provided for in section 1103, Act of October 3, 1917, authorized July 31, 1918]

A DISCUSSION OF THE DEVELOPMENT AND NEEDS

OF THE

COLLEGE OF ENGINEERING

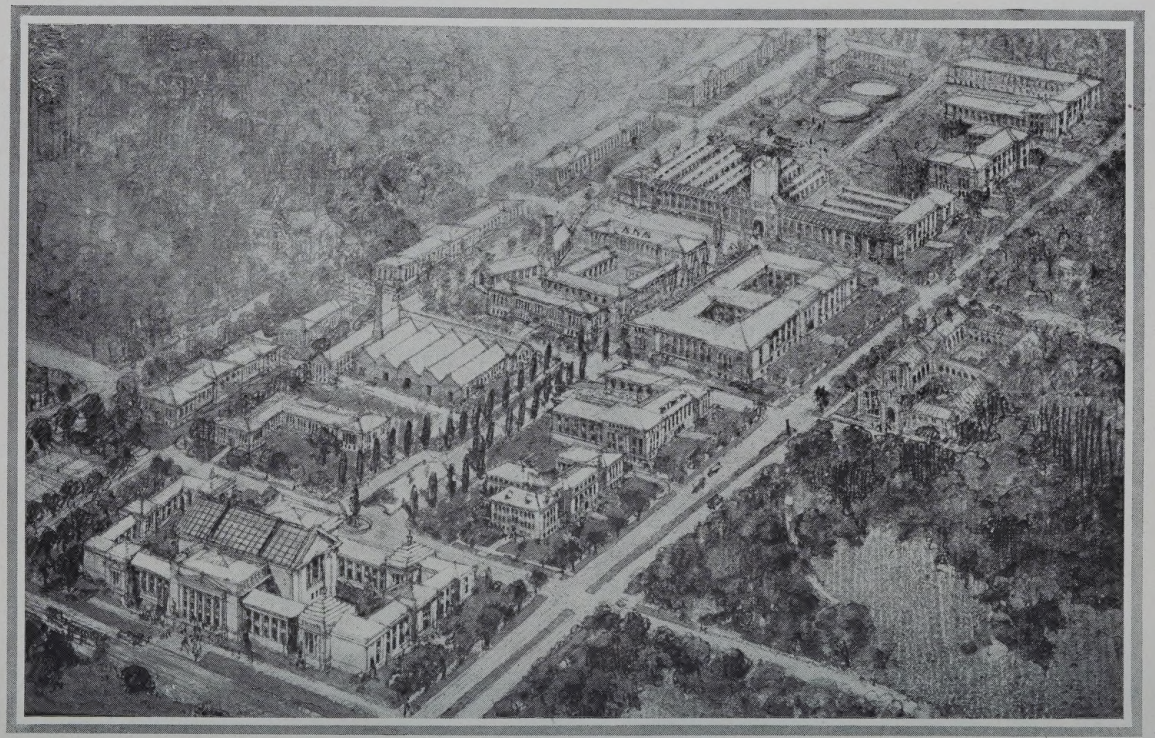
AND THE

ENGINEERING EXPERIMENT STATION

OF THE

UNIVERSITY OF ILLINOIS

PUBLISHED BY THE UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS



A Study for the Extension of the Campus of the College of Engineering, Looking Northeast.
Prepared by the Staff of the Department of Architecture

A DISCUSSION OF THE DEVELOPMENT AND NEEDS

OF THE

COLLEGE OF ENGINEERING

AND THE

ENGINEERING EXPERIMENT STATION

OF THE

UNIVERSITY OF ILLINOIS

PREPARED FOR THE INFORMATION OF THE

PRESIDENT AND THE BOARD OF TRUSTEES

BY

THE DEAN AND HEADS OF DEPARTMENTS

1919

URBANA, ILLINOIS

CONTENTS

CONTENTS (CONTINUED)

THE NEED FOR TECHNICAL TRAINING AND RESEARCH

OUR experience during eighteen months of war has fully demonstrated the value to the Nation of the men who have had scientific and technical training, and of the accumulated knowledge developed from scientific research. All the ingenuity of man has been applied in the advancement of the art of modern warfare, and consequently the work of the engineer, of the chemist and of the physicist has been of as great or possibly of even greater importance to the successful prosecution of the contest as that of the fighting men in the Army. The need to solve a great variety of new problems quickly has demanded the best efforts of our engineers and scientists, and the marvelous results of their work stand as monuments to their ability, efficiency and patriotism.

The rapid completion of the National Army cantonments and flying fields, the construction of enormous plants for the manufacture of explosives and all other munitions of war, for the fixation of atmospheric nitrogen and for the housing of labor, the construction of our emergency fleet and of the astonishing dock and other terminal facilities in France and in America, the network of railways and telephone lines in France, the development of vast cold storage and other warehouses for the maintenance of our Armies in France, the organization of the motor transport and tank service, the development of new devices and processes to combat the cunning of the enemy, the reorganization of the industries, the remarkable work of the chemical warfare service, and all the other achievements of America, which have required the proper coördination of science and industry, have excited the admiration and respect of the world.

Many people in America have regarded our vast natural resources of soil, coal, oil and minerals as practically inexhaustible, and they have wasted these resources in the most prodigal manner. With the methods of coal mining now employed, only about 50 per cent of the available coal is recovered, and as a result of wasteful methods of preparation, transportation and utilization of coal, the percentage of available fuel in the ground, which is finally usefully employed, is so small as to excite the apprehension of engineers. Similar conditions prevail in the extraction of oil from the ground, although engineers and scientists recognize that the conservation of our oil resources is of fundamental importance to our future industrial development. It has required only a short period of war to show conclusively that this country must provide for a more effective regulation of the use of our fuel and mineral resources, which will insure maximum efficiency in their recovery and utilization. The attention of engineers and chemists must be directed to these problems, and it is only by a careful scientific study of these important industrial and economical questions that we can hope to prolong the time required for the exhaustion of these resources.

As a result of the war, industry in America will undoubtedly be stimulated, because it has been forced to depend upon its own resources and develop new products which heretofore were imported from abroad, and to overcome conditions the like of which this country has never before met. For four years the principal nations of Europe have undertaken no construction except such as was essential to the prosecution of the war, and for nearly two years a similar condition has prevailed in America. During this awful period the destruction of property has been appalling. With the advent of peace, the need for the reconstruction of the industries of the nations at war, and for the extension

of new industries developed because of war-time necessity, will present problems, the successful solution of which will have the most far-reaching effect on the future of the countries concerned. America must play a leading part in this reconstruction work. It must supply competent men trained as engineers and as scientists to assist in the work at home and abroad. It must provide the means for scientific and technical training and for scientific research to insure that the country will never again return to a condition involving such careless waste as has prevailed in the past.

The response of the colleges and their graduates and students to the Nation's call for help has again afforded striking proof that education develops in men and women a fine sense of patriotism and responsibility and a spirit of service and self-sacrifice. These qualities in its citizens are important and valuable to the State in time of peace, and they are indispensable in time of war.

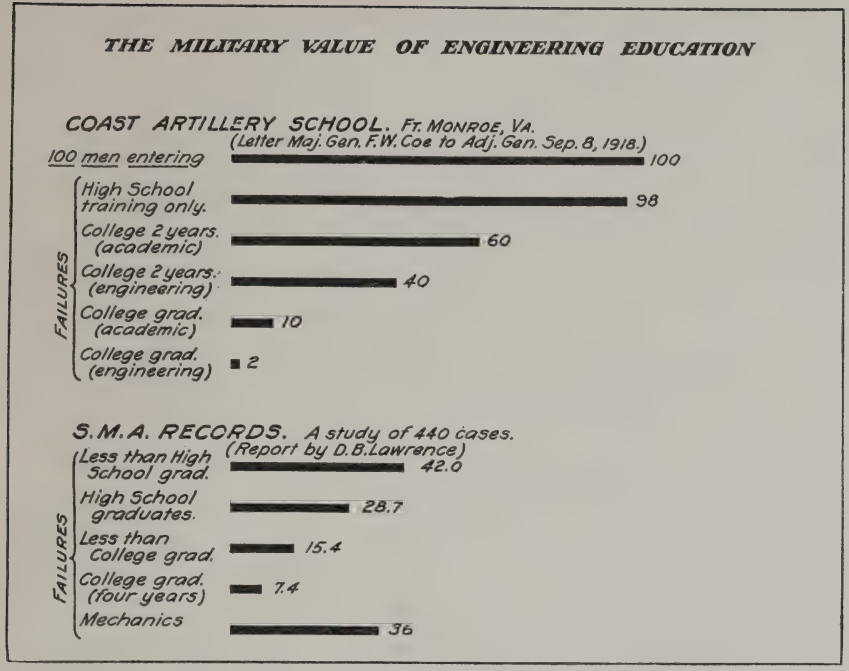
The war has demonstrated not only the importance of technical education, of science and of scientific research in the solution of important industrial problems, but it has also shown some striking illustrations of the value of education to the individual as well as to the Nation. In the organization of our Army and of our Navy, it was early found that in most branches of the service a college education is a distinct asset, for the advanced training of the individual rendered him more adaptable and more successful in meeting the requirements of the service. A few striking illustrations are typical of a condition which has been definitely recognized by Government officials. Thus, in the Coast Artillery Officers' Training School, it has been found that practically all the men without a high-school education failed, that of the graduates of high schools 98 per cent failed, that of persons having two years of academic college training 60 per cent failed, while of those persons having

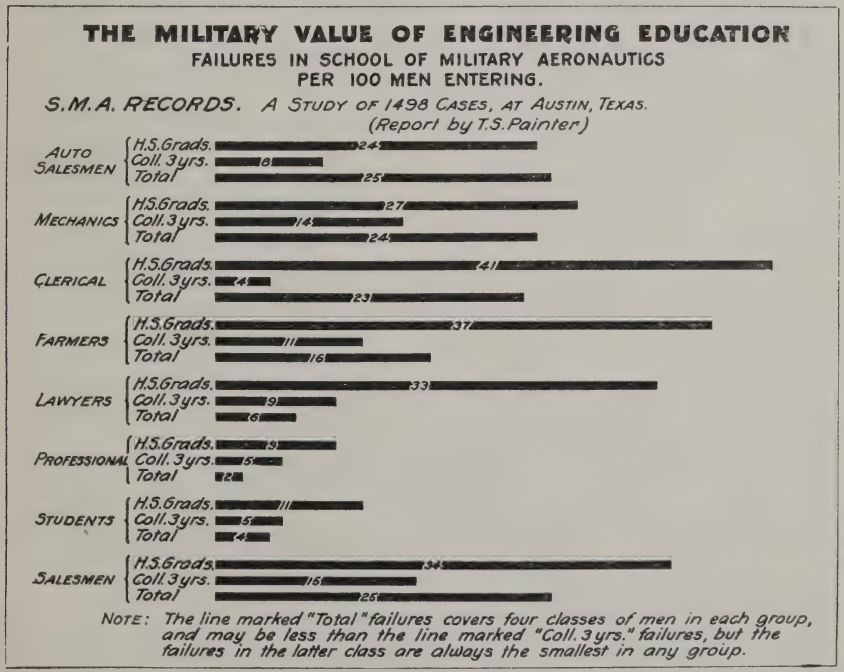
two years of engineering college training 40 per cent failed. It was further found that among the graduates of academic college courses only 10 per cent failed, while among the graduates of engineering colleges, the percentage of failures was so small as to be negligible. An investigation in several of the so-called "ground schools" of the Aviation Service has disclosed a condition somewhat similar to that described in the Coast Artillery. In fact, the importance of an education has been so fully recognized in the Air Service of the Army that recruiting officers have been requested to rate men according to their educational preparation as follows: College graduates, "very favorable"; not less than two years of college education, "favorable"; high school graduates, "neutral"; partial high school training, "unfavorable"; less than high school training, "disqualifying."

In every branch of the Government service a college degree has counted for much, assuming that this evidence of educational preparation was possessed by men whose personal and physical qualifications were acceptable, and during recent years the demand of the industries for technically trained men has been far in excess of the supply. During the past year the Government has spent $200,000,000 on various educational processes designed to prepare young men as technicians or for entrance to Officers' Training Schools.

Examples of the importance of technical training could readily be multiplied indefinitely, but the value of education and research has come to be so generally recognized by the people of this country that it seems unnecessary to present further arguments in favor of the proper maintenance of institutions of learning.

In the following pages an effort is made to show why the people of the State of Illinois cannot ignore the conditions which lead to industrial prosperity and supremacy, nor the agencies which will advance the industrial and social interests of the State.


THE MILITARY VALUE OF ENGINEERING EDUCATION
COAST ARTILLERY SCHOOL. Ft. Monroe, Va.
(Letter Maj. Gen. F.W. Coe to Adj. Gen. Sep. 8, 1918.)
100 men entering
100
FAILURES
High School training only.
98
College 2 years. (academic)
60
College 2 years. (engineering)
40
College grad. (academic)
10
College grad. (engineering)
2
S.M.A. RECORDS. A study of 440 cases.
(Report by D.B. Lawrence)
FAILURES
Less than High School grad.
42.0
High School graduates.
28.7
Less than College grad.
15.4
College grad. (four years)
7.4
Mechanics
36


THE MILITARY VALUE OF ENGINEERING EDUCATION
FAILURES IN SCHOOL OF MILITARY AERONAUTICS
PER 100 MEN ENTERING.
S.M.A. RECORDS. A Study of 1498 Cases, at Austin, Texas.
(Report by T.S. Painter)
Auto Salesmen
H.S. Grads.
24
Coll. 3 yrs.
8
Total
25
Mechanics
H.S. Grads.
27
Coll. 3 yrs.
14
Total
24
Clerical
H.S. Grads.
41
Coll. 3 yrs.
4
Total
23
Farmers
H.S. Grads.
37
Coll. 3 yrs.
11
Total
16
Lawyers
H.S. Grads.
33
Coll. 3 yrs.
9
Total
6
Professional
H.S. Grads.
9
Coll. 3 yrs.
5
Total
2
Students
H.S. Grads.
11
Coll. 3 yrs.
5
Total
4
Salesmen
H.S. Grads.
34
Coll. 3 yrs.
16
Total
26
NOTE: The line marked "Total" failures covers four classes of men in each group, and may be less than the line marked "Coll. 3 yrs." failures, but the failures in the latter class are always the smallest in any group.

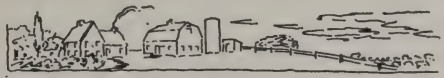
THE RESOURCES OF ILLINOIS

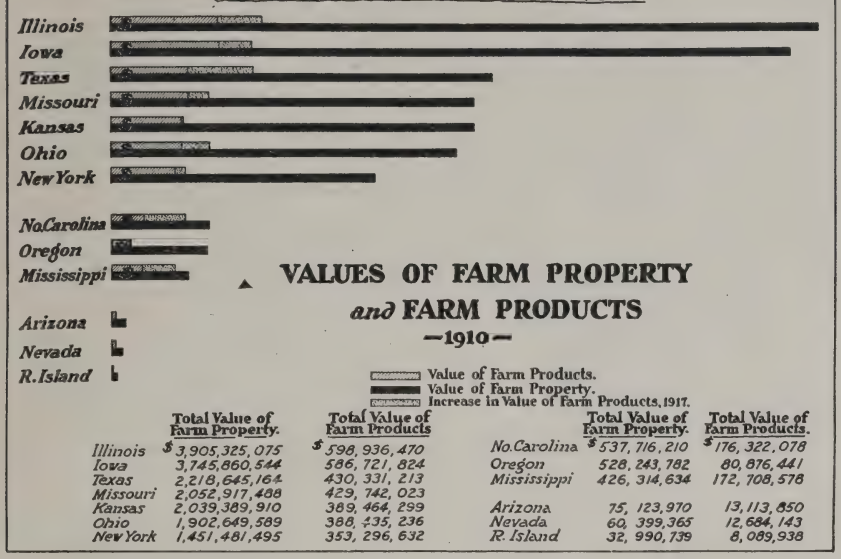
THE prosperity and relative standing of any commonwealth depend upon the variety and extent of its natural resources, the diversity of its industries, the accessibility of necessary raw materials not produced within its own boundaries, the location of markets for its surplus products, the extent of its transportation facilities, and the intelligence and initiative of its people. In America few other states lead Illinois in the possession of resources which so fully meet these conditions, and in no other state are the possibilities for future industrial development so promising.

Illinois has an area of 56,665 square miles, 56,043 square miles being land, of which 90.7 per cent is in farms, and most of them are under cultivation. Because of the fertility of its soil, the State has for many years ranked as one of the leaders in the value of its agricultural property and in the gross annual receipts from its agricultural products. Thus, in 1910 the value of all farm property in the State was estimated at approximately $4,000,000,000, giving it first place among the states of the Union, and in 1917 the gross annual value of its farm products was $842,042,000, which was exceeded by no other state.

Below the surface of this great agricultural state there is an area of approximately 36,800 square miles of coal in seams of sufficient thickness to justify mining operations. Of these vast coal resources, estimated at 201,399,808,000 to 240,000,000,000 tons, only about one per cent has so far been used and rendered non-recoverable. From the latest available sources of information, the total estimated value of the coal mining property in the State is $160,000,000, and the value of the coal mined in 1917 was $162,281,822, placing Illinois third among all the states.

In addition to its coal resources, Illinois is a large



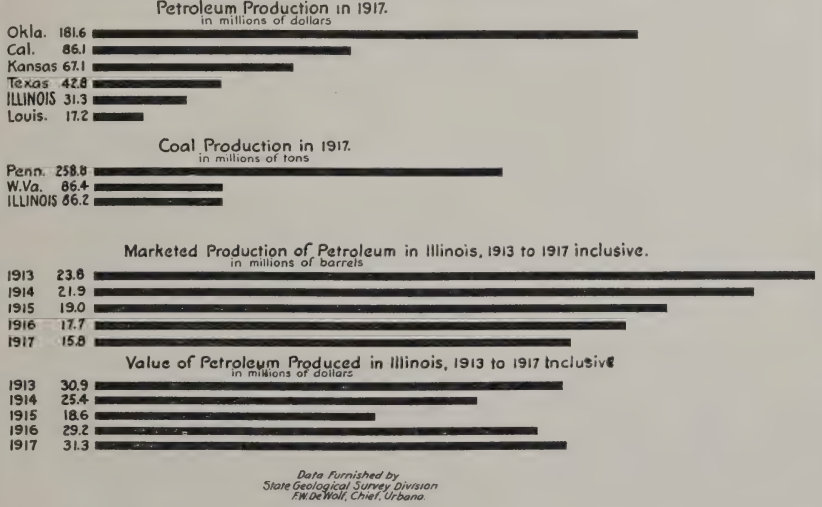


VALUES OF FARM PROPERTY *and* FARM PRODUCTS —1910—

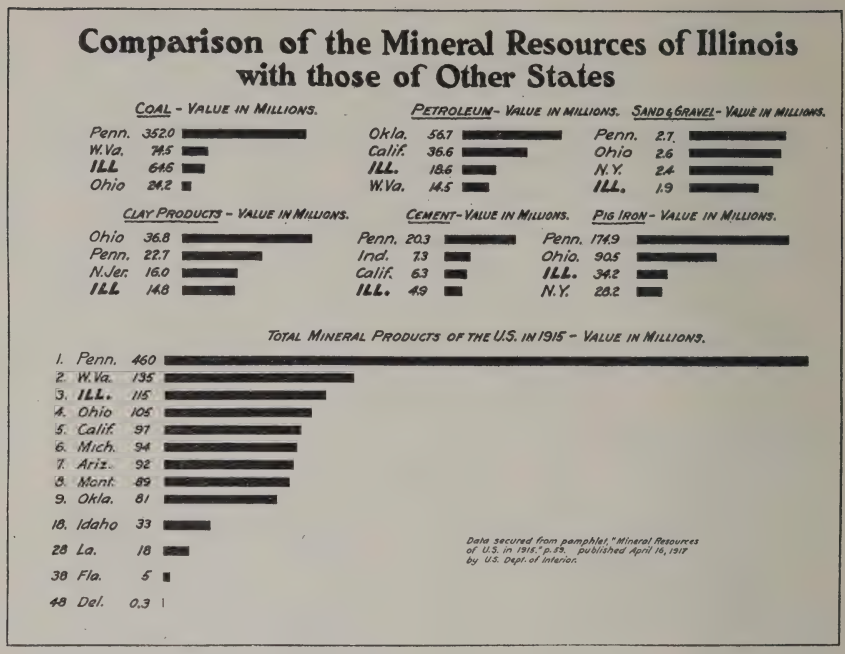
Value of Farm Products.
Value of Farm Property.
Increase in Value of Farm Products, 1917.

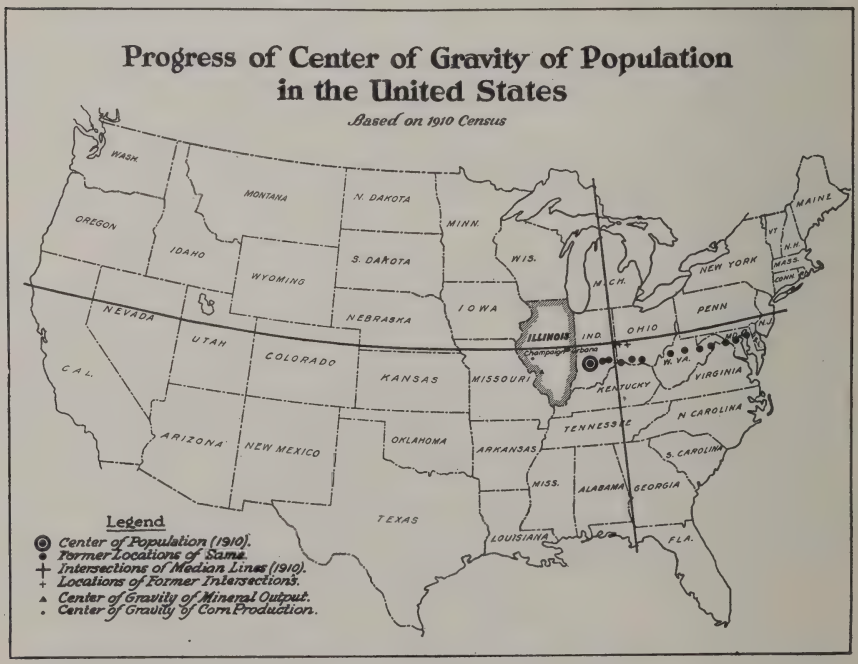
	Total Value of Farm Property.	Total Value of Farm Products		Total Value of Farm Property.	Total Value of Farm Products.
Illinois	$3,905,325,075	$598,936,470	*No. Carolina*	$537,716,210	$176,322,078
Iowa	3,745,860,544	586,721,824	*Oregon*	528,243,782	80,876,441
Texas	2,218,645,164	430,331,213	*Mississippi*	426,314,634	172,708,578
Missouri	2,052,917,488	429,742,023			
Kansas	2,039,389,910	389,464,299	*Arizona*	75,123,970	13,113,850
Ohio	1,902,649,589	388,435,236	*Nevada*	60,399,365	12,684,143
New York	1,451,481,495	353,296,632	*R. Island*	32,990,739	8,089,938

The Production of Petroleum in Illinois



Data Furnished by
State Geological Survey Division
F.W. DeWolf, Chief, Urbana.


Comparison of the Mineral Resources of Illinois with those of Other States
COAL - VALUE IN MILLIONS.
Penn. 352.0
W.Va. 71.5
ILL. 64.6
Ohio 24.2
PETROLEUM - VALUE IN MILLIONS.
Okla. 56.7
Calif. 36.6
ILL. 18.6
W.Va. 14.5
SAND & GRAVEL - VALUE IN MILLIONS.
Penn. 2.7
Ohio 2.6
N.Y. 2.4
ILL. 1.9
CLAY PRODUCTS - VALUE IN MILLIONS.
Ohio 36.8
Penn. 22.7
N.Jer. 16.0
ILL 14.8
CEMENT - VALUE IN MILLIONS.
Penn. 20.3
Ind. 7.3
Calif. 6.3
ILL. 4.9
PIG IRON - VALUE IN MILLIONS.
Penn. 174.9
Ohio. 90.5
ILL. 34.2
N.Y. 28.2
TOTAL MINERAL PRODUCTS OF THE U.S. IN 1915 - VALUE IN MILLIONS.
1. Penn. 460
2. W.Va. 135
3. ILL. 115
4. Ohio 105
5. Calif. 97
6. Mich. 94
7. Ariz. 92
8. Mont. 89
9. Okla. 81
18. Idaho 33
28 La. 18
38 Fla. 5
48 Del. 0.3
Data secured from pamphlet, "Mineral Resources of U.S. in 1915," p. 25, published April 16, 1918 by U.S. Dept. of Interior.


Progress of Center of Gravity of Population in the United States
Based on 1910 Census
WASH.
OREGON
CAL.
IDAHO
NEVADA
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
N. DAKOTA
S. DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINN.
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WIS.
ILL.
IND.
OHIO
KENTUCKY
TENNESSEE
MISS.
ALABAMA
GEORGIA
FLA.
S. CAROLINA
N. CAROLINA
VIRGINIA
W. VA.
PENN
N.Y.
MICH.
MAINE
VT.
N.H.
MASS.
CONN.
R.I.
N.J.
Champaign
Urbana
Legend
Center of Population (1910).
Former Locations of Same.
Intersections of Median Lines (1910).
Locations of Former Intersections.
Center of Gravity of Mineral Output.
Center of Gravity of Corn Production.

producer of crude petroleum and of natural gas. The production of oil in 1917 amounted to 15,776,860 barrels, so that as an oil producing state, Illinois ranks fifth,—a change from third place in 1915.

The "mineral center" of the United States lies within the boundaries of Illinois. The State produces some lead and zinc ore, and it has the largest zinc smelters in America. It is the largest producer of fluor-spar, and it has extensive deposits of sand and gravel. There are also vast deposits of clay and limestone, and Illinois now has come to be one of the leading states in the manufacture of cement and clay products. There are still some undeveloped natural resources which may assume importance in the future. Thus, there are deposits of ganister, glass sand, and oil shales which may ultimately become of considerable economic importance.

While Illinois has generally been characterized as an agricultural state, it has for many years occupied a leading position because of the importance and variety of its manufacturing industries. While there have been no reliable statistical data since the 1914 census report, it is interesting to note that at that time Illinois had an investment of $1,943,836,000 in its manufacturing plants, and that these industries produced annually commodities valued at $2,247-323,000. At that time Illinois occupied third place among the manufacturing states of the country. Whether these relative figures still hold is uncertain. It is true, however, that since 1914 the development of manufacturing in the State has been rapid, and that because of cheap fuel, the variety of available raw materials and the convenience of transportation, the State should make progress which would carry it beyond the position which it now occupies, in comparison with other states.

The transportation facilities of Illinois are unusually

extensive. According to the Illinois Public Utilities Commission's Report for 1915, the total mileage of steam railroads within the State is 23,897, including double tracks and sidings, which is probably exceeded by no other state, although Texas may have a greater effective mileage of such roads; the total mileage of electric railways is 3,448, which is exceeded by only three other states; the approximate value of all railway property which may be considered as an asset of the State was estimated at $1,438,000,000 in 1913; and the gross annual receipts from all railway operation was $250,125,258 for the same year.

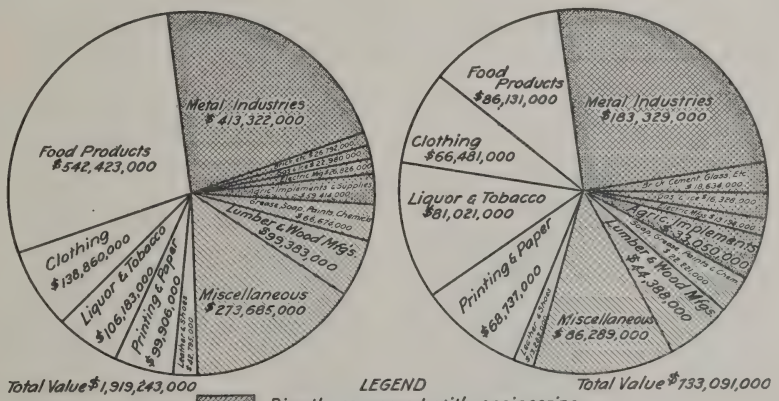
Not only has Illinois remarkable railway facilities, but it possesses relatively unexploited waterways, which undoubtedly will sometime assume greater relative importance in the State. The Mississippi River forms the whole western boundary of the State, while the Ohio River forms a portion of its southern boundary. The Illinois River is navigable for a considerable distance, and this stream, in connection with a canal system now in existence, makes it possible to go by water from Lake Michigan to the Gulf of Mexico. If a deep waterway from the Lakes to the Mississippi is ultimately provided, it may greatly increase the prestige of the State as an exporter of foodstuffs and manufactured products, and much of the apparent advantage of those states which lie along the Atlantic seaboard may be overcome.

According to data compiled in 1912, the total wealth of Illinois was $15,484,450,232. At that time the wealth per capita in this State was $2,660. The total wealth of Illinois was exceeded only by New York with $25,011,105,223, with a wealth per capita of $2,626. It is interesting to note that Pennsylvania had an estimated wealth of $15,457,530,277, with a wealth per capita of $1,939.

TOTAL VALUE OF MANUFACTURED PRODUCTS OF ILLINOIS AS COMPARED WITH OTHER STATES

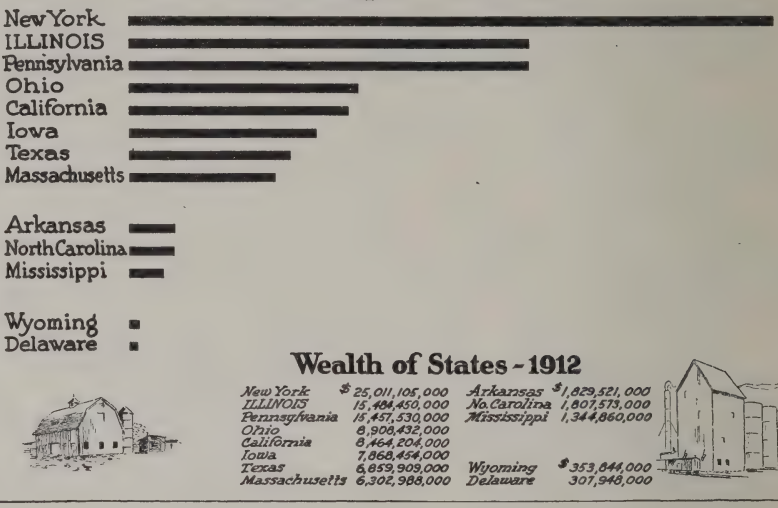
—1914—

New York	$3,814,661,000	Maryland	$377,749,000
Pennsylvania	2,832,350,000	Texas	361,279,000
ILLINOIS	2,247,347,000	Kansas	323,234,000
Ohio	1,782,806,000	Iowa	310,750,000
Massachusetts	1,641,373,000		
New Jersey	1,406,633,000	Nevada	16,083,000
Michigan	1,086,162,000	Wyoming	11,224,000
		New Mexico	9,320,000



VALUE OF ALL PRODUCTS MANUFACTURED IN ILLINOIS. —1910—

INCREASE IN VALUE OVER COST OF RAW MATERIALS OF ILLINOIS MANUFACTURED PRODUCTS. — 1910.

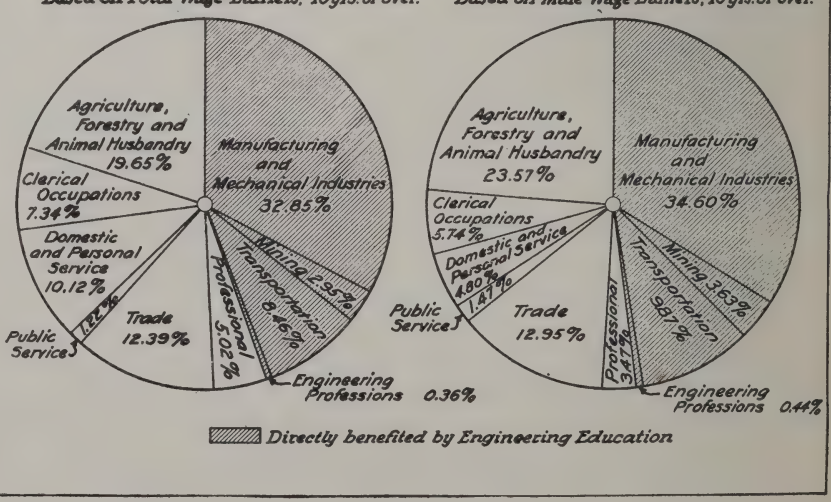


Wealth of States - 1912

New York	$ 25,011,105,000	Arkansas	$ 1,829,521,000
ILLINOIS	15,484,450,000	No. Carolina	1,807,573,000
Pennsylvania	15,457,530,000	Mississippi	1,344,860,000
Ohio	8,908,432,000		
California	8,464,204,000		
Iowa	7,868,454,000		
Texas	6,859,909,000	Wyoming	$ 353,844,000
Massachusetts	6,302,988,000	Delaware	307,948,000

Occupations of the People of Illinois

1910 Census Report



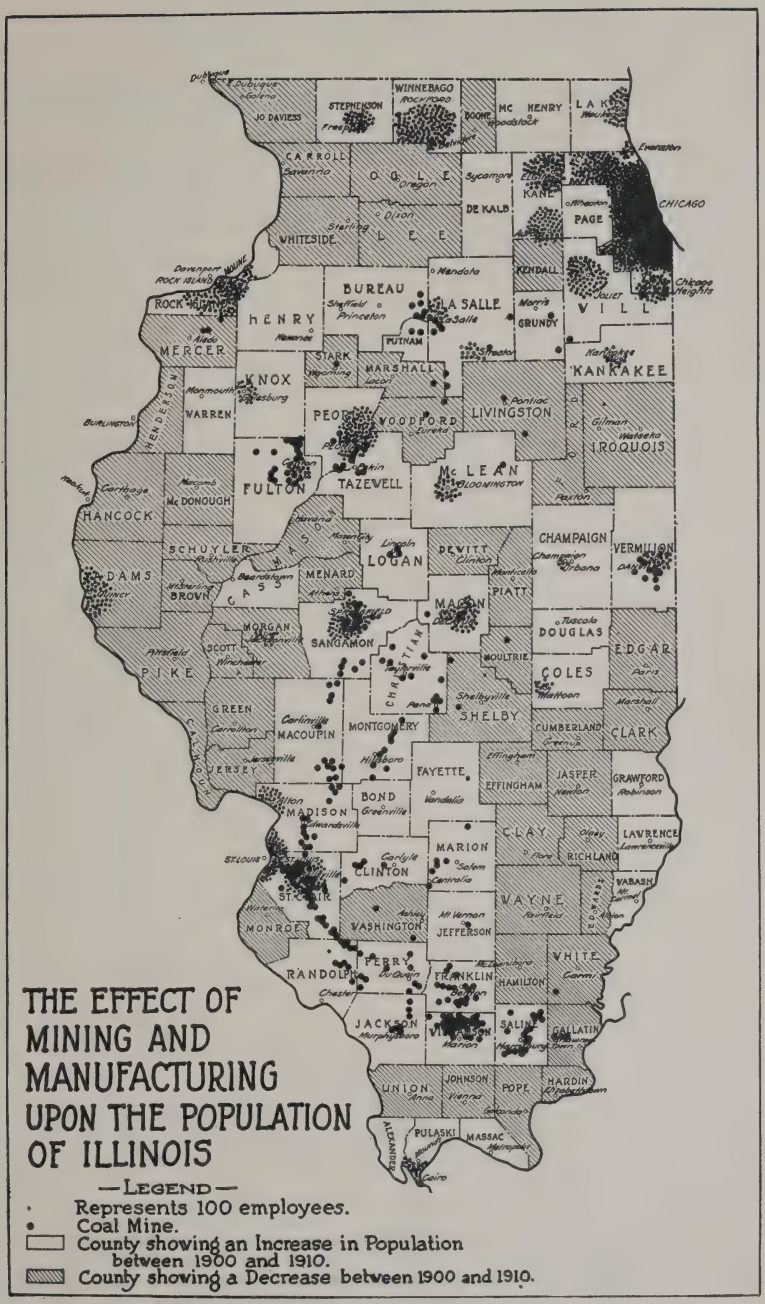
In a number of the states whose population is small, the per capita wealth exceeds that of the states mentioned, although their total wealth falls very far below the figures given for these three states.

According to estimates of the United States Census Bureau, the population of Illinois on January 1, 1917 was 6,193,626. The population of this State was exceeded only by New York which had 10,366,778, and by Pennsylvania which had 8,591,029. One interesting conclusion which results from an examination of the estimated population statistics for 1917 as compared with 1910 is that with the exception of Texas, the states which have shown the largest percentage of growth are those in which manufacturing plays the most important part. An analysis of the distribution of population in Illinois, based upon occupations, and using the data based on total wage earners, presented in the 1910 census, indicates that 19.65 per cent of the people of the State are engaged in agriculture, 35.8 per cent in manufacturing and mining, 8.46 per cent in the transportation industries, 29.85 per cent in trade and in domestic and personal service, and 6.24 per cent in professional and public service. As the manufacturing, mining, transportation, and general business interests of the State develop, the percentage of persons engaged in these occupations will be increased.

In view of the extent of the natural resources of the State, particularly its resources in fuel, of its enormous production of raw materials, of the excellence of its transportation facilities, and of the fact that it lies near the geographical center of the country, and that it is within a few miles of the center of population, it seems reasonable to predict that its industrial development will be rapid, and as has been previously indicated, that the apparent advantage possessed by those states along the seaboard

will in a large measure be overcome. While it is to be hoped that war will never again convulse the world, yet as a measure of safety against invasion by a foreign foe, the Nation should do all that it can to stimulate the development of industries remote from the sea.

While the future development of industry in the community will depend very largely upon private initiative, all the people of the State are concerned in its rapid development and enduring prosperity. As the representative of the people, the Legislature has large responsibilities in these developments, and it should encourage them by every means at its disposal. Education in general and technical education in particular are of fundamental importance to the future success of the industrial and business interests of the State, and the proper support of the State's educational institutions will represent a kind of investment which may be expected to yield large returns. The College of Engineering of the University of Illinois has been organized to train men in the engineering sciences and to contribute to the knowledge of such sciences through research. The people of Illinois should expect to have facilities for the education of their children which will compare with the facilities available elsewhere. The interests of this institution and those of the people of the State are mutual, for the institution is organized to serve the State.

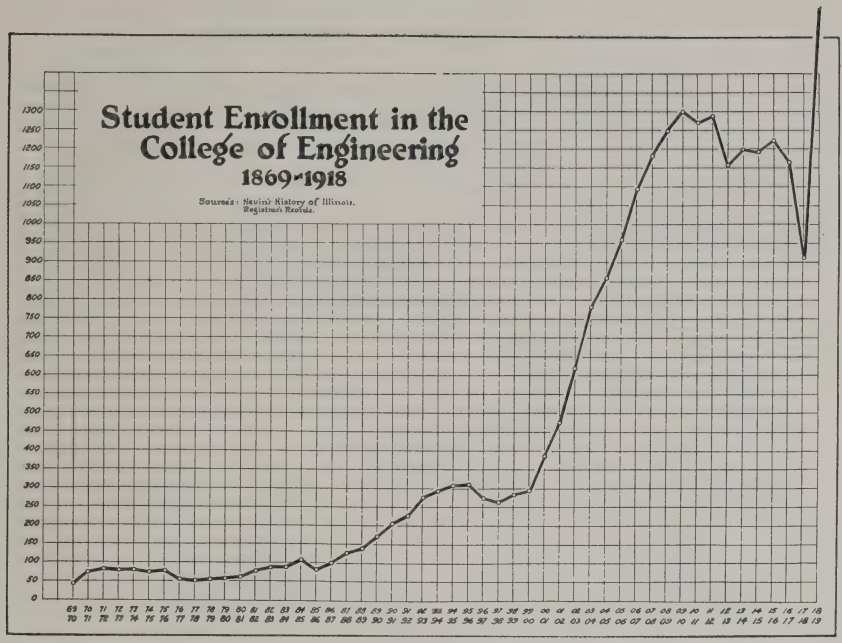

THE EFFECT OF MINING AND MANUFACTURING UPON THE POPULATION OF ILLINOIS
—LEGEND—
Represents 100 employees.
Coal Mine.
County showing an Increase in Population between 1900 and 1910.
County showing a Decrease between 1900 and 1910.
WINNEBAGO
MC HENRY
LAKE
STEPHENSON
JO DAVIESS
BOONE
CARROLL
OGLE
KANE
CHICAGO
DE KALB
PAGE
WHITESIDE
LEE
KENDALL
BUREAU
LA SALLE
HENRY
GRUNDY
WILL
ROCK ISLAND
MERCER
PUTNAM
STARK
MARSHALL
KANKAKEE
KNOX
WARREN
PEORIA
WOODFORD
LIVINGSTON
IROQUOIS
HENDERSON
FULTON
TAZEWELL
McLEAN
HANCOCK
McDONOUGH
CHAMPAIGN
VERMILION
SCHUYLER
LOGAN
DEWITT
ADAMS
BROWN
MENARD
PIATT
MASON
MORGAN
SANGAMON
DOUGLAS
EDGAR
SCOTT
MOULTRIE
PIKE
COLES
CHRISTIAN
GREEN
SHELBY
CUMBERLAND
CLARK
MACOUPIN
MONTGOMERY
JERSEY
FAYETTE
EFFINGHAM
JASPER
CRAWFORD
BOND
MADISON
CLAY
LAWRENCE
MARION
RICHLAND
CLINTON
ST. CLAIR
WAYNE
WABASH
MONROE
WASHINGTON
JEFFERSON
EDWARDS
WHITE
PERRY
RANDOLPH
FRANKLIN
HAMILTON
JACKSON
SALINE
GALLATIN
UNION
JOHNSON
POPE
HARDIN
PULASKI
MASSAC
ALEXANDER

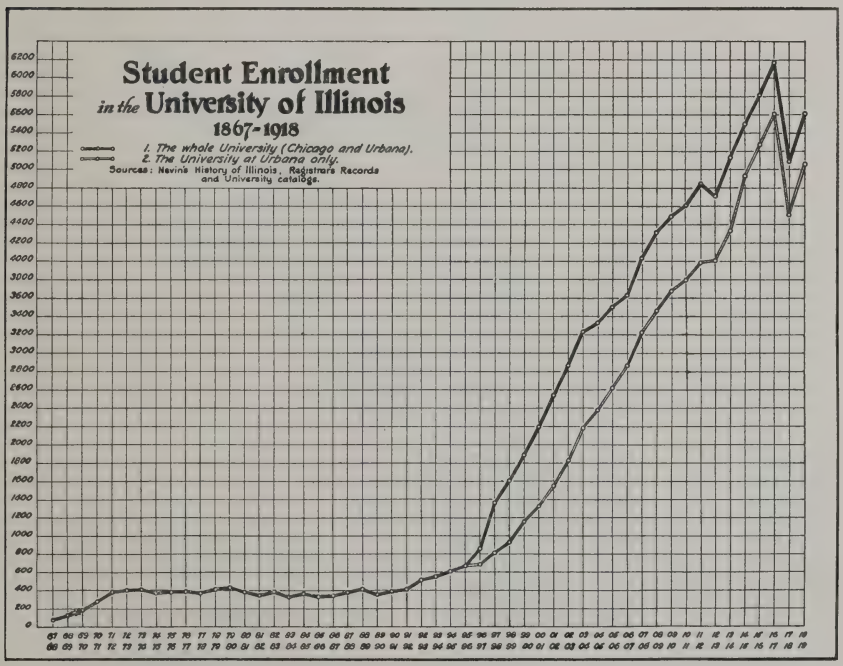
THE DEVELOPMENT OF THE COLLEGE OF ENGINEERING

IT was only about fifty years ago that a really serious attempt to educate men for engineering and other industrial pursuits was undertaken in America. Although the organization of the Rensselaer Polytechnic Institute in 1824 afforded an opportunity for instruction in civil engineering,— the only branch of the profession then recognized, except military engineering,— and at various later dates a number of educational institutions gave instruction in the elements of mathematics, mechanics, and science underlying the art of the engineer, the real development of engineering education began less than fifty years ago as a result of the passage of the Land Grant College Act in 1862.

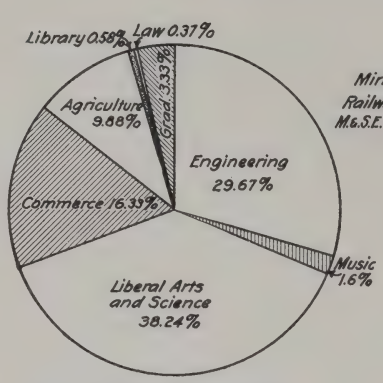
When the University of Illinois was established in 1867 as the Illinois Industrial University, agriculture and engineering were given special prominence in the institution. Instruction in the rudiments of architecture, or perhaps more properly in architectural construction, in civil engineering and in mechanical engineering was given. During this early period a number of significant experiments in education were made, perhaps the most noteworthy of which was the introduction of shop work into the college curriculum. To the College of Engineering of the University of Illinois belongs the credit for this innovation as well as for others which have since been made in the development of its technical courses.

Fifty years ago engineering was an art rather than a science, and as a consequence the work of the early technical schools contained many courses of a practical nature, such as shop work, mechanical drawing, and surveying, while the courses in the fundamental sciences were exceedingly elementary in comparison with present-day standards.

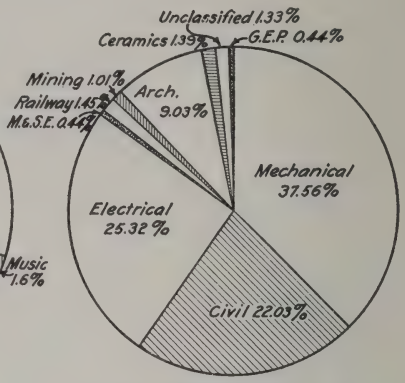

Student Enrollment in the College of Engineering
1869-1918
Sources: Nevin's History of Illinois, Registrar's Records.


Student Enrollment in the University of Illinois
1867-1918
1. The whole University (Chicago and Urbana).
2. The University at Urbana only.
Sources: Nevin's History of Illinois, Registrar's Records and University catalogs.

DISTRIBUTION OF STUDENTS
FOR THE YEAR 1918-1919
University of Illinois

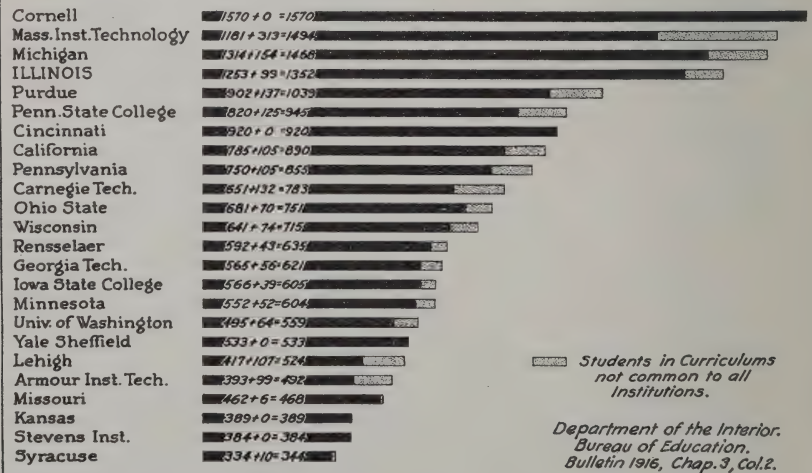


BY COLLEGES IN THE UNIVERSITY AT URBANA.



BY DEPARTMENTS IN THE COLLEGE OF ENGINEERING.

Comparison of Student Enrollment in the Leading Engineering Colleges



Department of the Interior.
Bureau of Education.
Bulletin 1916, Chap. 3, Col. 2.

During this period the phenomenal progress in science and industry has imposed many new responsibilities upon the engineering colleges, necessitating many radical changes in their methods of instruction and many additions to their curriculums. These colleges have been prompt in their efforts to meet such changing conditions in the industrial life of the Nation, and they have exercised a profound influence on the development of science and industry in this country.

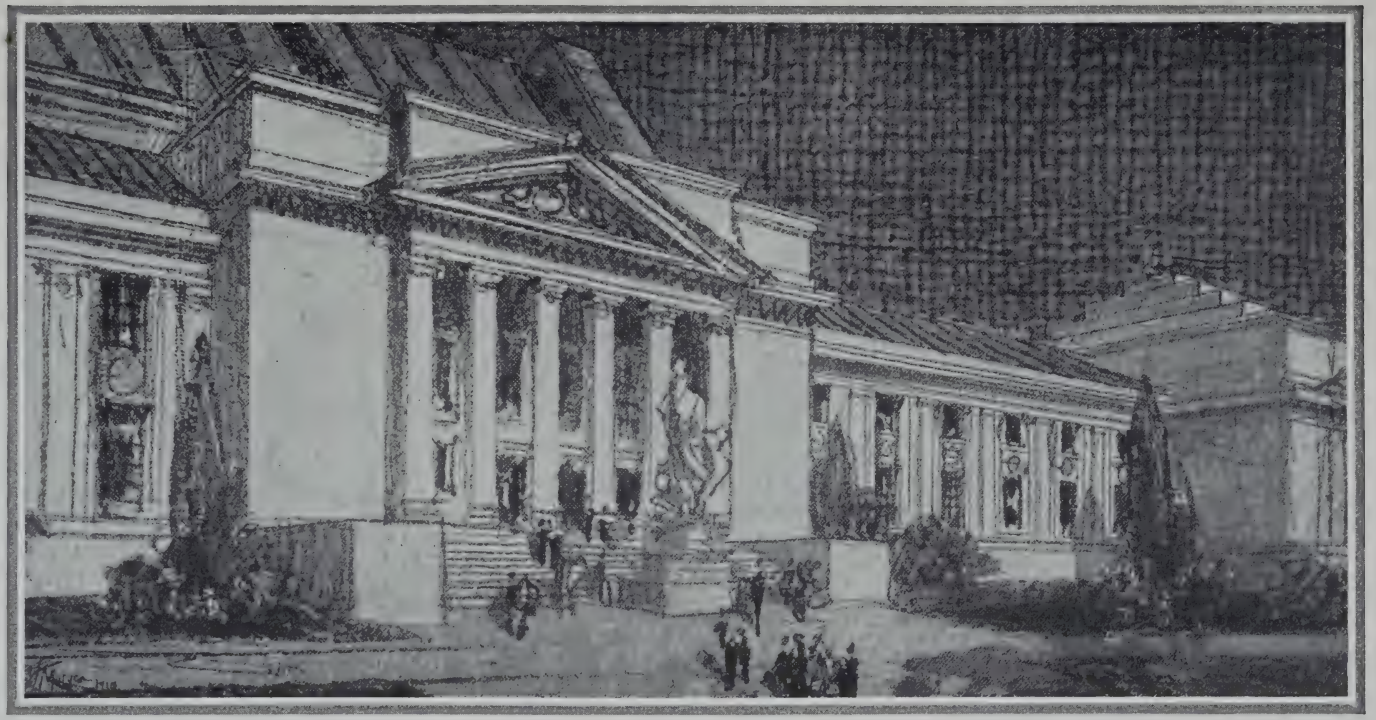
The College of Engineering was the first of the colleges in the University of Illinois to secure any considerable enrolment of students, and it was the first to obtain a high standing in comparison with other institutions in the country. As recently as 1895, the enrolment of undergraduate students in the College of Engineering was 311, while the whole University had an enrolment of only 573. Fifteen years later the enrolment of undergraduate students in the College of Engineering had reached 1,288, while the University had a total enrolment of 3,393. During this period the College of Engineering came to be recognized as one of the leaders among the technical schools of America in the strength of its faculty, in its facilities for instruction and in its enrolment of students. At the present time its enrolment of students is exceeded only at the Massachusetts Institute of Technology, Cornell University, and the University of Michigan. During recent years the average annual enrolment of students in the College has been approximately 1,200. Last year as a result of war-time conditions the maximum enrolment was reduced to 891. For the present year, largely as a result of the organization by the War Department of the Students' Army Training Corps, the enrolment in the College has been increased to 1,585.

The College of Engineering now offers four-year curric-

ulums in architecture, architectural engineering, ceramic engineering, civil engineering, electrical engineering, mechanical engineering, mining engineering, municipal and sanitary engineering, general engineering physics, railway civil engineering, railway electrical engineering, and railway mechanical engineering, each leading to the degree of Bachelor of Science; and it is organized into ten departments, as follows:

The Department of Architecture.— Instruction in architectural construction and later in architectural design was given in the College of Engineering almost from its beginning. The organization of this department at a place remote from great works of art and of architecture, and the development of its work and facilities for instruction so they are comparable with the best in the world, has been a remarkable accomplishment. Because of the value and popularity of its work, the enrolment of students in the department before the war was exceeded in no other institution in the world, and it attracted students from many states and from foreign countries. It is difficult to estimate the influence this department has exerted in creating a demand for the construction of safe, comfortable, convenient, and artistic buildings in the State, but it has undoubtedly been large, for the graduates of the department are widely scattered, and each of them has left his impress upon the community in which he lives.

The Department of Architecture has participated in many activities for the betterment of building conditions of the State. It was concerned with the passage of the law for the licensing of architects, and for more than twenty years it has had a representative on the Board of Examiners; it has advocated the construction of better and more artistic buildings throughout the State; and it has



A Study for the Front Elevation of the Proposed Architectural Building, Prepared by the Staff of the Department of Architecture

coöperated in the solution of problems connected with civic improvements. In 1917, when a portion of the city of Mattoon was destroyed by a tornado, this department prepared drawings for the reconstruction of the devastated area.

The Department of Architecture administers two curriculums of study, one in architecture and the other in architectural engineering. The former deals largely with problems of architectural design, the latter with problems of engineering and architectural design and construction. The curriculum in architecture seeks to develop a correct appreciation for the artistic in building design, while the curriculum in architectural engineering seeks to train men to coöperate with architects in the safe and economical construction of buildings and their proper equipment.

The Department of Ceramic Engineering.— The creation of the Department of Ceramic Engineering in 1905 was authorized by the Legislature in response to demands from the Illinois Clay Workers' Association for a department devoted to their interests, which would offer instruction in the science of ceramics and undertake research of importance in the development of these industries in the State.

This request for a highly specialized technical training was made by men who were thoroughly familiar with the industry and who possessed a broad vision of its importance and of the need for an adequate training of young men who would be called upon to take leadership in the development of the industry and of the clay resources of the State. These men realized the dependence of modern civilization upon the ceramic industry for the materials necessary in great industrial enterprises, in engineering projects and in the ordinary needs of life. Industrial

expansion had made large demands upon the ceramic industries, which they were not fully prepared to meet. For centuries the craft had been shrouded in mystery, and the rule of thumb methods and great secrecy concerning processes prevailed. Since other industries had profited through the employment of technically trained men, it seemed evident that such training was fundamental to the future success of the clay-working interests.

Ceramic engineering is concerned with the technology of the industries engaged in the manufacture of clay products, glass, cement, lime, gypsum, enameled iron and similar products. The work of the department deals with the scientific principles underlying the ceramic industries, and it affords an opportunity for training in a field which is of growing importance in Illinois, and which will be greatly benefited through the utilization of trained engineers and of the knowledge resulting from scientific research.

There are relatively few institutions which are organized to offer work in ceramic engineering. This department at the University of Illinois is probably the best equipped and best prepared to do important work in the instruction of students and in the science of the subject of any educational institution in the world. At the earliest possible date it should be permitted to add the necessary equipment and to offer additional courses of instruction in ceramic art and in the manufacture of cement and glass.

The department has rendered noteworthy service to the people of the State through coöperation in the development of its clay and related mineral resources, through assistance in over-coming manufacturing difficulties and losses, through the design of an improved commercial kiln now extensively used, through the discovery of a method for the preliminary heat treatment of certain clays, which greatly reduces the losses resulting from their use, through

its investigations relating to the composition of glass and of glazes, and through its graduates who are filling many positions of responsibility.

An important feature of the educational work of the department, which has attracted wide and favorable attention from men who are interested in the advancement of the ceramic industries, has been the Short Course in Ceramic Engineering. Practical men from Illinois and many other states have registered in this course, and they have greatly profited by the lectures given and by the demonstrations shown.

The Department of Civil Engineering.—The work of the Department of Civil Engineering is of special importance to the people of Illinois, since the duties of the civil engineer have a direct bearing on the health, comfort and prosperity of the people of the commonwealth. The department has undertaken to stimulate the spirit of service in its students, and to develop in them a capacity for leadership which will enable them to occupy positions of responsibility in the community, and to direct and carry through undertakings of importance to the public welfare. While the curriculum in civil engineering includes the principles of the physical and mathematical sciences and their general application to engineering, it is arranged to permit the student to specialize in one or more important divisions of work, such as highway engineering, drainage engineering and structural engineering.

At the present time the State of Illinois is vitally interested in the development of its highways, and the people of the State have authorized the expenditure of $60,000,000 for the construction of hard roads. In the preparation of a comprehensive plan for highway improvements and in the supervision of construction work, it is

important that the best available engineering advice be secured. Illinois is reputed to have the largest number of miles of poor roads of any state in the Union, and consequently no subject should be of greater interest to the people of the State than that of highway improvement and the training of men to take leadership in this important branch of engineering.

Next in importance to the development of a proper system of highways is the extension of the drainage systems of the State. In Illinois, with its vast areas of rich, productive soil, the drainage of the land presents many complicated and difficult problems involving a knowledge of soil physics, of engineering and of law. The solution of these important problems should not be intrusted to untrained men. Undoubtedly in the future there will be an increasing demand for men who have had proper educational preparation for this work.

Since the civil engineer is called upon to design a great variety of structures, such as bridges, viaducts, buildings and dams, structural engineering is recognized as one of the most important divisions of civil engineering. Its varied and spectacular contributions to the convenience and comfort of the people probably excite the greatest public interest of any work which the engineer is called upon to do. The department also gives some attention to the problems of irrigation and land reclamation, and to questions connected with the construction of public works, canals, hydraulic developments, etc.

In addition to its regular work, the department has given a Short Course in Highway Engineering each winter during the past few years. This course is planned to meet the needs of highway superintendents and others who are concerned with the construction and maintenance of roads. On several occasions, the department has held a Drainage

Conference for the discussion of the numerous important questions connected with the drainage and reclamation of land in Illinois.

The Department of Electrical Engineering.—The University of Illinois was one of the first institutions in the world to organize a department for the training of electrical engineers. This department was organized over twenty-five years ago when the rapid development in the applications of electricity created a demand for specialists in this new field of engineering. Since its organization 656 students have completed the requirements for graduation, and they are serving as consulting electrical engineers and are engaged in work with large electrical manufacturing corporations, with public utilities in various communities throughout the State, and as teachers in technical schools. The phenomenal development of electrical science, creating a demand for large numbers of experts, together with the spectacular and facinating nature of work in this field, has rendered the curriculum in electrical engineering an unusually attractive one to young men.

The work of this department, in common with that of the other engineering departments, is founded upon the physical and mathematical sciences. It seeks to apply these sciences to the solution of the varied and complicated problems with which the electrical engineer has to deal in the generation and distribution of electrical energy by direct and alternating currents, the design of electrical machinery, the application of electricity and magnetism to the telegraph, the telephone and to wireless signaling, and in all the other marvelous applications of electrical energy.

In addition to its training of men for service in the electrical industries, the department has been particularly

active in stimulating an interest in advanced graduate study and in scientific research. It has made numerous important contributions to the principles of electrical science.

The Department of General Engineering Drawing.—The Department of General Engineering Drawing provides for the proper instruction of engineering students in the principles of mechanical drawing and descriptive geometry. Since all engineering students are required to take drafting and to become reasonably proficient in the art of mechanical drawing, the sign language of the engineer, it was considered desirable that this fundamental subject be given by a department which is independent of the specialized departments of the College.

Since the department is principally concerned with the instruction of freshman students in all the engineering curriculums, and is, therefore, the first point of contact between the new student and the College of Engineering, it has a large responsibility and a great opportunity to create enthusiasm in the minds of these new students for the work which the College is organized to promote. The value of mechanical drawing to the engineer is inestimable, for detailed drawings must be prepared in advance of all construction work.

The Department of Mechanical Engineering.—Prior to the development of the steam engine and before machinery began to play an important part in the industrial and economic life of the people, civil engineering was the only branch of the profession which had been developed. The wonderful advances in invention and industry made during the nineteenth century, following the perfection and introduction of the steam engine, led to the need for a more specialized study of problems concerned with the produc-

tion and application of power, and the creation of a new division of engineering, known as mechanical engineering. This branch of the profession is concerned primarily with the generation, transmission and utilization of power, and with the design, construction and operation of machinery of all kinds. The work of the mechanical engineer is fundamental to all manufacturing processes, and consequently the opportunities open to the graduates of the department are of the most varied kind. It is impossible, therefore, to anticipate completely the future needs of its graduates, and to provide the infinite variety of specialized instruction which might prove useful to men who finally enter some particular manufacturing or other industrial enterprise. The curriculum in Mechanical Engineering has been planned to give a thorough training in mathematics, physics, chemistry, thermodynamics, machine design, machine construction, steam and gas power engineering, the heating and ventilation of buildings, and in the application of these subjects to the general engineering and economic problems connected with the manufacturing industries.

Its graduates have played an important part in the State in the design, erection, and management of power plants, in the manufacture of agricultural implements and a great variety of other machinery, and in the management of public utilities and other important industries.

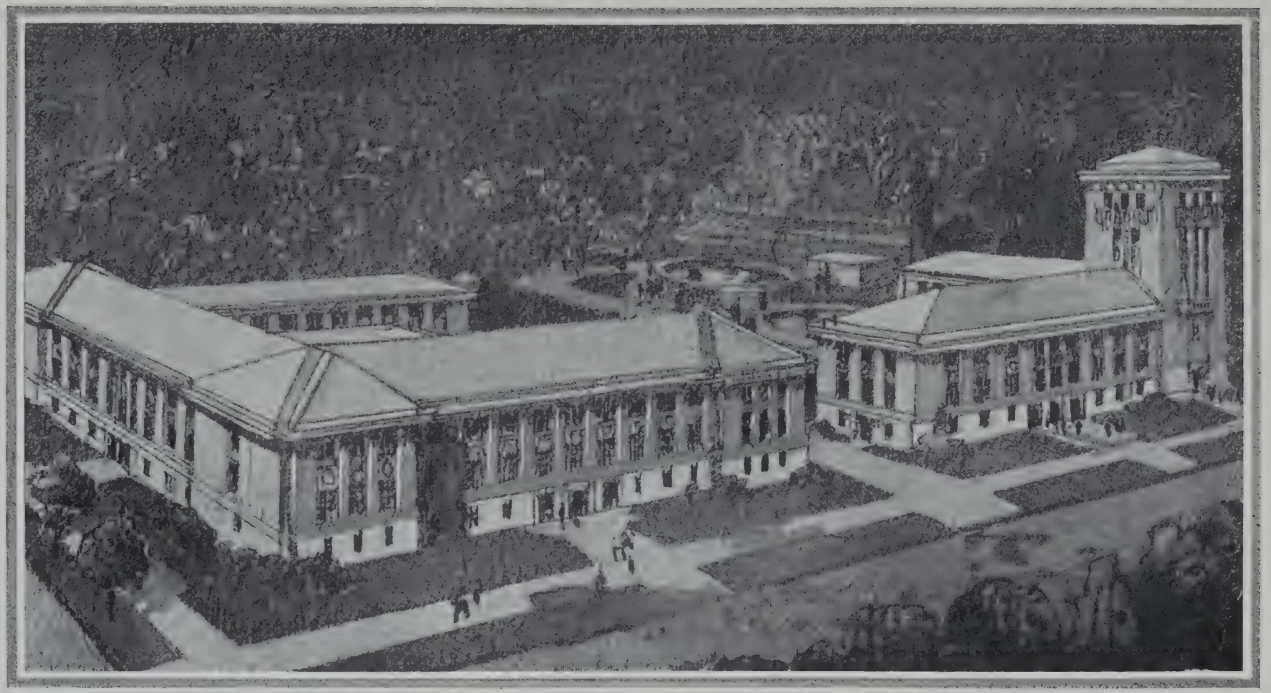
The Department of Mining Engineering.—The Department of Mining Engineering was established as a result of a request for such a department presented to the Legislature by a committee representing the mine operators, the United Mine Workers, the State Mine Inspectors, and the manufacturers of the State of Illinois. The act establishing the department provided "that in addition to offering such courses of instruction as will best train young men for

efficient work in the various phases of mining industries, the department shall concern itself with the development and dissemination of scientific facts that will be of value to the mining industry and will conserve life and the resources of the State."

This department offers courses of instruction in the several branches of mining and metallurgical engineering. Because of the importance of coal mining in this State, the department has given particular attention to the mining, preparation, and storage of fuel, and it has rendered real assistance to the coal mining interests. An opportunity is offered for specialized instruction in all branches of mining work and in metallurgy.

This department has coöperated with the State through the Mining Investigations and Mine Rescue Commissions, and the establishment of a State Mine Rescue Service and Miners' Institute can be traced directly to the establishment of this department at the University. Under a coöperative agreement between the Engineering Experiment Station, the United States Bureau of Mines and the State Geological Survey, for an investigation of coal mining conditions in the State, the Department of Mining Engineering has contributed very largely to the knowledge of the mining, preparation, and utilization of coal. This information concerning mining conditions in Illinois has been rendered available to every one interested through the publications of the Engineering Experiment Station and of the other agencies which have participated in the investigations.

The Department of Municipal and Sanitary Engineering.— Modern cities have developed numerous and complicated engineering requirements, among which are those concerned with the furnishing of an abundant and whole-



A Study of the Proposed Building for Municipal and Sanitary Engineering, Theoretical and Applied Mechanics and Civil Engineering, and of the Hydraulic Laboratory.
Prepared by the Staff of the Department of Architecture

some supply of potable water, distributed under pressure through pipes to every place where it is used; the construction of wells, impounding reservoirs, lake intakes, and other means of developing this water supply, and of works for its purification; sewerage systems which will receive and convey to the point of disposal the liquid wastes of the city and provide means for the treatment of this sewage in localities where it is not permissible to discharge it directly into streams or lakes; the construction of pavements, walks, bridges, viaducts, and other features of city streets; the drainage of the surface to carry the runoff from rainfall and melting snow; and a variety of measures involving sanitation and the public health. Our cities have been unable to construct public improvements commensurate with their growth, and from present indications their growth during the next decade will exceed that of the past. To bring city conditions up to standards in keeping with the growth of urban population, and the requirements of sanitary science and proper civic pride will involve skill and foresight in planning and executing new public works.

The Department of Municipal and Sanitary Engineering aims to keep in touch with those developments in engineering which relate to civic and sanitary matters and to assist in solving the problems of city work. The curriculum in municipal and sanitary engineering affords instruction in the design, construction, and operation of municipal public works and of other engineering work connected with hydraulic and sanitary engineering. It also includes the usual work in mathematics and science, in surveying, structural materials and design, in the generation and transmission of power, and in the properties and bacteriology of water supply and sewage disposal. It can be seen that the work of the department is related to important interests of the many cities of the State, and that it

may be expected to be increasingly important in the future.

The importance of the work and the need for development in the many municipal problems warrant greater attention being given to the work of the department. An increase in the working staff is greatly needed, especially in lines of water purification, sewage disposal and hydraulic and sanitary construction. Attention should also be called to the need for opportunities and facilities to carry on experimental work relating to water purification, sewage treatment, the disposal of garbage and other features connected with the sanitation of cities. These are pressing questions in which most of the cities of the State should be interested.

It seems proper to call attention to the important work which has been carried on at the University by the State Water Survey, now the Water Survey Division of the State Department of Education and Registration. This organization in its experimental and advisory work, reaching out to cities all over the State, has accomplished very much in maintaining proper standards of purity for water, in stimulating interest in sanitation and in the dissemination of information relating to sanitary science. Its research work has made valuable contributions to the knowledge of water and sewage. These activities have been very helpful to the University and especially to the students in municipal and sanitary engineering.

The Department of Physics.— A thorough knowledge of the science of physics is fundamental to the training of every engineer. He must be familiar with the laws of heat, sound, light, electricity and magnetism, and mechanics. Because of the importance of physics to the engineer, it is fortunate that the Department of Physics is a department of the College of Engineering, acting in full accord

with the other departments in their efforts to promote the highest type of engineering instruction and engineering and scientific research.

While the principal function of the Department of Physics is to provide proper instruction for all engineering students, it administers a curriculum in general engineering physics, which, while similar to the other engineering curriculums, gives especial emphasis to the more advanced work in physics, which is essential in all physical and engineering research. This curriculum was planned to prepare its graduates to become teachers of physics to engineering students, or to engage in physical research as applied to the industries of the country. Many of the large industrial corporations now maintain research laboratories with staffs of engineers, physicists, and chemists, whose whole time is devoted to the investigation of problems of vital interest to the industry. Not infrequently, however, these laboratories undertake research work in fields not directly connected with the principal interests of the company maintaining the laboratory. As the realization of the importance of scientific research and its application to industrial conditions becomes more widespread, there will be a large increase in the demand for men who have had training such as that provided by this curriculum.

The Department of Physics is housed in a new and thoroughly modern fireproof building. It has facilities for instruction and for research in certain phases which are surpassed at no other institution in this country. In its work, this department has rendered a distinct service in the State through its training of teachers of this important science, and through its instruction of students in engineering, chemistry, medicine, mathematics, agriculture, and general science. In its research work, also, it is rendering a great service in developing scientific data.

The Department of Theoretical and Applied Mechanics.— All students in the College of Engineering are given instruction in mechanics, the science which deals with the forces and deformations which must be considered in the design and construction of bridges, buildings, machines, and other engineering structures, and with the motions set up in machines. Mechanics is a fundamental study for all branches of engineering work which is essential in the solution of problems connected with the strength of parts in the design, construction, and operation of every structure or machine. Instruction in mechanics includes a study of the laws of resistance of wood, iron, steel, concrete, and other materials of construction when loads are applied to the parts of structures and machines; it also includes a study of the experimental methods used in the materials testing laboratory for determining the properties of engineering materials, and a study of the standard tests and specifications which materials must meet to insure the safety of structural and machine parts. There has been a very great development in the art of testing materials of construction during recent years.

The instruction in this department includes a study of hydraulics, which deals with the flow of water through pipes, canals, channels, and conduits, and the problems found in the development of water power. No problems of engineering touch the daily life of the people more closely than those of water supply and drainage, and a knowledge of the laws of hydraulics is fundamental in the consideration of such problems.

Opportunities are also given for advanced work in the analytical treatment of the more difficult problems found in mechanics and in the analytical and experimental problems connected with the properties and action of wood, steel, and concrete construction. Investigations of engi-

neering materials and of the action of structures are constantly made. Many important tests have been carried out in the Laboratory of Applied Mechanics. All this work is of immediate applicability to the construction and manufacturing activities of the people of the State.

The demands upon the department are increasing rapidly. For the maintenance of proper standards in the college, it is essential that there be members on the staff who know in an authoritative way the practice and the requirements of engineers for the wide range of materials now used in the industries, and who are able to contribute to our knowledge on these matters. The great growth which has come with the developments in manufacturing and construction has brought about a necessity for specialized technical knowledge. There are many varieties of steel, such as carbon steel, vanadium steel, and tungsten steel, and there are special requirements for the steel used for particular purposes in the manufacture of automobiles, airplanes, locomotive and car parts, and a variety of other articles. The heat treatment of steel is an illustration of the many special topics. It is apparent that the technology of the materials of engineering is an important field. In construction lines, the great development of concrete and reinforced concrete, the use of fire-resisting materials and the fireproofing of buildings, and the use of new forms of design in buildings and bridges have greatly increased the field of this work. The developments of the age have also extended to laboratory tests and testing, both in the field of engineering materials and in that of hydraulics. Larger equipment and better facilities are urgently needed. New problems are constantly arising which require new apparatus for their treatment. The technique of testing is becoming more and more important.

An effort has been made to keep up with the develop-

ments of the engineering world, and much has been accomplished. It is evident, however, that there are opportunities and responsibilities which call for considerable expansion in experimental facilities and in the staff. It is felt that the addition of laboratory facilities and of new members to the laboratory and teaching staffs would be of advantage to the industrial and constructional interests of the State as well as to the students of the University.

The Department of Railway Engineering.—Elsewhere mention has been made of the importance of the transportation interests in Illinois, both as to the extent of the railways and the investments in such properties, and of the number of people who are directly concerned with the operation of the railways of the State. Because of the importance of transportation in the development of the State and of the Nation, the College of Engineering has undertaken, through its Department of Railway Engineering, to give specialized instruction in the different branches of engineering science, which are closely related to this subject. To emphasize further the importance of the work in this field, the University has provided a School of Railway Engineering and Administration to coördinate the work of the Department of Railway Engineering with that of the College of Commerce and Business Administration, which provides instruction in railway organization and administration.

The Department of Railway Engineering administers three curriculums: one in railway civil engineering, one in railway electrical engineering and one in railway mechanical engineering. While these curriculums are not dissimilar from the regular curriculums in civil, electrical and mechanical engineering, respectively, they are planned to emphasize the problems connected with the design, construction, maintenance and operation of all kinds of railway equip-

Photograph of the Transportation Building, with Sketch of the Proposed Addition

ments and structures. Thus, the curriculum in railway civil engineering deals with the questions of track location, with the design and construction of railway bridges and railway shops, and with the varied railway terminal facilities. The curriculum in railway electrical engineering provides for specialized instruction in the application of the general principles of electrical engineering to transportation. It deals with the design, construction and operation of electric locomotives and of electric railway cars, as well as with the other varied applications of electricity to this great industry. The curriculum in railway mechanical engineering deals with the design, construction, operation and maintenance of locomotives, cars and of other types of important mechanical equipment.

The lecture rooms, drafting rooms and offices of this department occupy a portion of the Transportation Building. In addition it is provided with a Locomotive Testing Laboratory which is superior to any similar laboratory in the world. As noted elsewhere, for its full and adequate development, its facilities need to be supplemented by the erection of a Railway Electrical Laboratory.

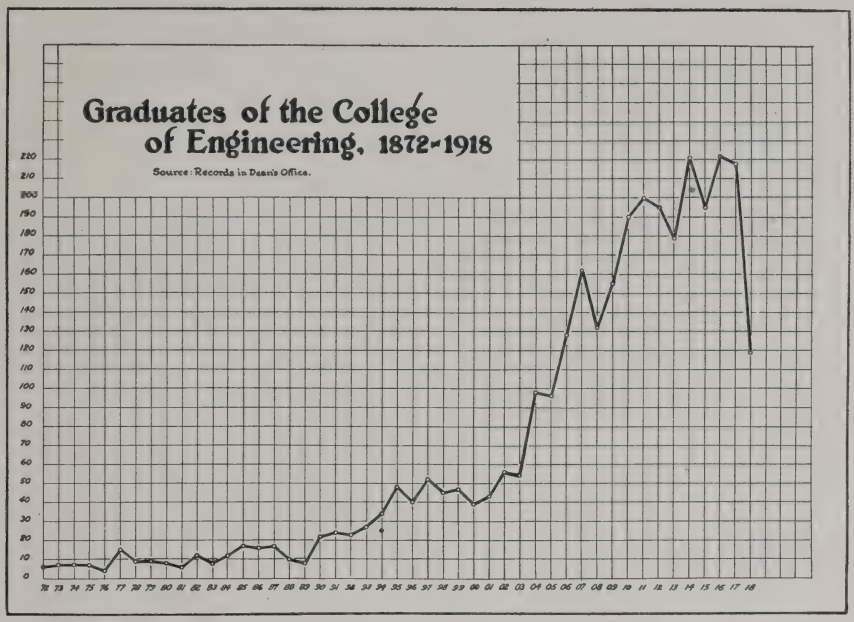
It is felt that the war has so thoroughly demonstrated the importance of transportation to the Nation that there will be an increasing number of students desiring the training which this department offers. Through its training of students and its contributions to the knowledge of the scientific principles of the subject, this department is rendering a unique service to the State and to the country. No other educational institution is so well prepared to do effective service in this field as the University of Illinois.

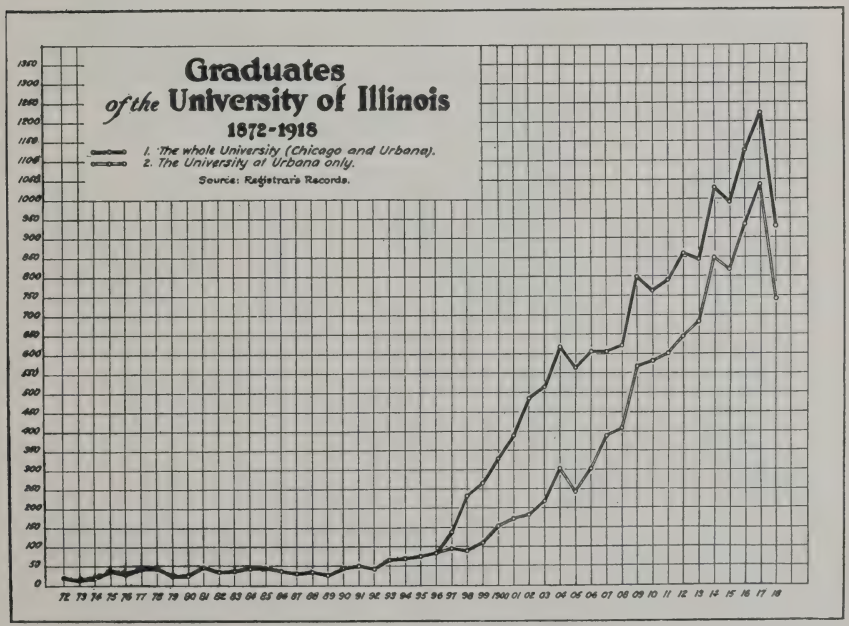
THE ALUMNI OF THE COLLEGE OF ENGINEERING

SINCE the principal function of the College of Engineering is the training of men for service in the engineering industries, the value of the institution to the State can best be gaged by the number of its graduates and by their achievements in the development of the technical interests of the commonwealth. While a majority of its alumni have become indentified with the industrial life of the State, the graduates of the College may be found in nearly every state of the Union and in a large number of foreign countries. The success they have achieved in their work is a fine testimony to the value of the training which they have received through the generosity of the State.

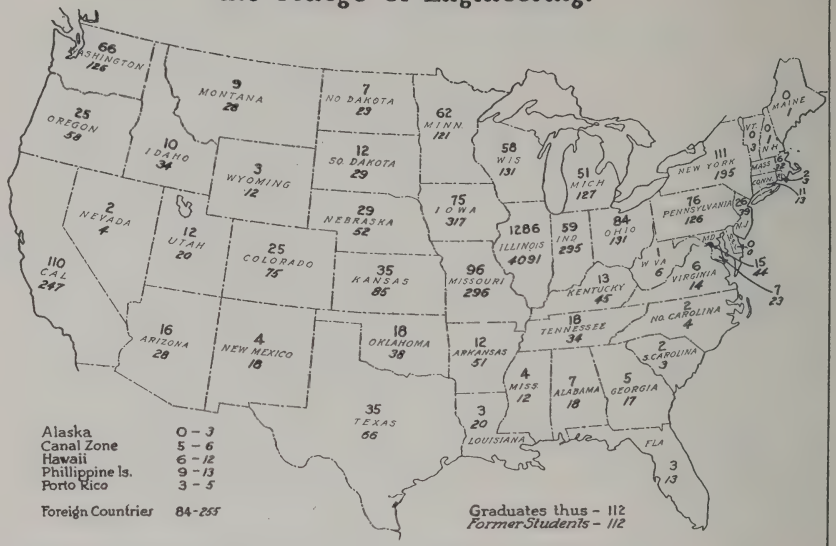
Up to the present time 3,299 students have received the baccalaureate degree in engineering from this institution. In 1914 a careful investigation showed that of the men who had graduated prior to that time, nearly eighty per cent were engaged in pursuits for which their training directly qualified them. Of the remainder, a considerable number were engaged in some business in which their engineering training was of distinct value. It is probable that few institutions in the country can show a like record, and it affords a striking proof of the practical value of the work done in the College and of the influence of this work in shaping the lives of its graduates. The influence of these men upon the communities in which they live is difficult to estimate. It may be safely asserted, however, that they have played an important part in advancing the business, industrial and political life of the people.

The graduates of this College are found in the list of employees and executives of many engineering and manu-

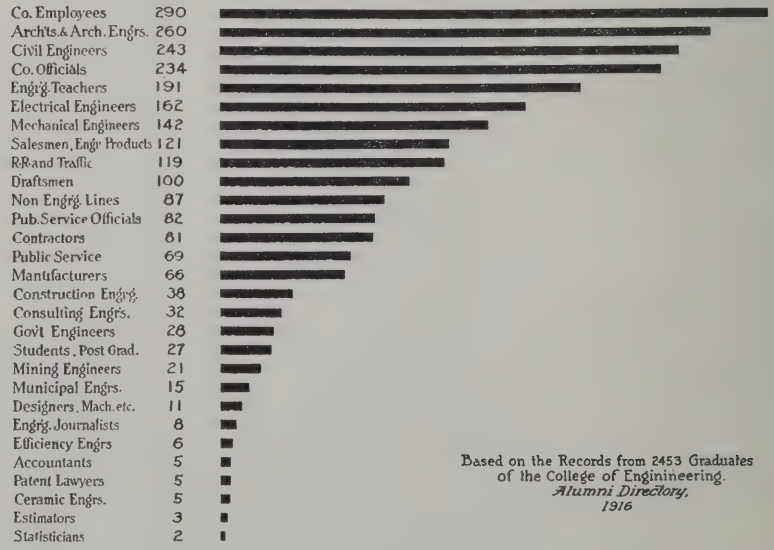

Graduates of the College of Engineering, 1872-1918
Source: Records in Dean's Office.


Graduates
of the University of Illinois
1872-1918
1. The whole University (Chicago and Urbana).
2. The University at Urbana only.
Source: Registrar's Records.

Distribution of Graduates and Former Students of the College of Engineering.



·DISTRIBUTION·OF·ENGINEERING·GRADUATES·IN· ·BUSINESS·AND·PROFESSIONAL·OCCUPATIONS·



Based on the Records from 2453 Graduates of the College of Enginineering.
Alumni Directory, 1916

facturing corporations, and many of them are practising their profession as architects and as consulting engineers. Many of the important engineering structures of the country, such as bridges, viaducts and buildings have been designed and constructed by these men. Many new machines and processes for increasing the efficiency of human labor have been perfected by them, and they have played an important part in the development and construction of public works of all descriptions.

The College of Engineering points with special pride to the achievements of its graduates during the war. Up to August 9, 1918, incomplete records showed that at that time not less than 459 graduates of the College were in the Army, and that many of these men were charged with responsibilities of the utmost importance. Thus, a group of Illinois men was largely instrumental in carrying through successfully the construction of the National Army Cantonments; others were prominently identified with the development of reinforced concrete ships; and many were rendering efficient service as officers in the various technical branches of the Army. Without doubt nearly every graduate of the College has contributed his best efforts to the successful prosecution of the war, either in the Army, or in the industries which were engaged in war work. In this connection, it is interesting to note that in addition to the large number of graduates who entered the Army or Navy, nearly 700 undergraduate students in the College of Engineering withdrew for military service, and that many former students, who did not graduate, have rendered effective service in the prosecution of the war.

For more than five years prior to 1918, the College of Engineering graduated approximately 200 men each year. In 1918, as a result of the war, the number in the graduating class was reduced to 118. From present indications, it

seems unlikely that the College will graduate more than 75 students at the close of the present academic year. With the return of its former students from the Army and Navy, and with the increased interest in technical education, which will inevitably follow the war, it may be expected that the number of graduates each year will soon be in excess of the largest number which heretofore received degrees in any one year.

THE ENGINEERING EXPERIMENT STATION

THE Engineering Experiment Station of the University of Illinois was established by an act of the Board of Trustees on December 8, 1903. This Station was organized to stimulate and to elevate engineering education, to study problems of special importance to professional engineers and to the manufacturing, railway, mining and other industrial interests of the State and of the country, and to render available the knowledge thus obtained through the publication of bulletins presenting the results of original research, and of circulars containing compilations of important information not readily accessible to the interests to be served.

The control of the Engineering Experiment Station is vested in an Executive Staff composed of the Director and his Assistant and the Heads of the several departments of the College of Engineering. The Executive Staff is charged with the responsibility of outlining the general policies for the control of the Station and for the character and extent of investigations to be undertaken, but the Head of each department is largely responsible for the research work carried on in his department. The Executive Staff is also responsible for the determination of the acceptablility of material presented for publication, and the results of every investigation are carefully scrutinized before their publication is authorized.

Research work may be conducted by any member of the staff of instruction of the College of Engineering and of the Department of Chemistry, and every effort is made to stimulate a spirit of scientific research in the teaching staff. The greater portion of the research work of the Station is, however, carried on by the Research Corps, which includes a

number of full-time investigators and a group of Research Graduate Assistants who devote half of their time to the research work of the Station, and the other half to graduate study in engineering. From time to time, as conditions may require, special investigators are employed for a limited period to devote their attention to the investigation of a specific problem. At the present time the Station maintains fourteen Research Graduate Assistantships, and two similar Assistantships in Gas Engineering have been established under the patronage of the Illinois Gas Association.

The Engineering Experiment Station of the University of Illinois was the first of its kind to be organized, and it has come to be recognized as one of the most active agencies in existence for the extension of knowledge of engineering science. It has served as a model for other similar stations established in various institutions in this country. Before the organization of the Station at the University of Illinois, efforts were made to secure federal support for engineering experiment stations to be established in the various states under conditions similar to those provided in the act authorizing the establishment of agricultural experiment stations. These early attempts to secure federal support for engineering experiment stations were unavailing. A bill for the establishment and maintenance of such stations is now pending before Congress and there is a possibility that the Government may provide funds for the conduct of engineering research which will supplement those provided by the several states.

The Engineering Experiment Station is simply an organization within the College of Engineering, created to emphasize research and to provide an agency for the publication of the results of such work. While a particular investigation may involve the purchase or construction of

special apparatus for the purpose, the principal work of the Station is conducted with the facilities provided by the College for the instruction of students. Thus, most of the scientific work in engineering is carried on in the same laboratories which are used for instruction, and, as a consequence, there is a stimulus to the student who realizes that he is working side by side with men who are devoting their best efforts to the extension of knowledge of the scientific principles of engineering.

In addition to the work of the Station already outlined, the members of the staff are called upon to answer inquiries and to furnish information concerning various engineering problems, and, occasionally, to conduct commercial tests of interest only to the individual or company requesting such tests, for which a charge is made to cover the expense involved. Normally, the Station will not undertake commercial testing except in cases where there are no other agencies in the State with facilities for conducting such tests.

Up to the present time the Engineering Experiment Station has published 110 bulletins and 8 circulars. All of these publications are valuable, and some of them present the results of investigations of the greatest importance, which may be regarded as real contributions to engineering science.

Probably none of the contributions of the Station have been more important or more highly regarded than those which have dealt with the strength and properties of engineering materials and of structures. For many years the Station has carried on a great variety of investigations in the field of reinforced concrete. This institution was a pioneer in this field of investigation, and the results of the work which has been completed, comprising a notable series of bulletins, has been of tremendous assistance to the engineering interests of the world, in connection with

the design of reinforced concrete structures. It is interesting to note that as a result of the prestige enjoyed by the Station on account of these investigations, graduates and former members of the Research Corps of the Station, who were interested in this subject, have played a very important part in the development of reinforced concrete ships under the direction of the Emergency Fleet Corporation. In the series of bulletins devoted to reinforced concrete, mention should be made of those which present important information concerning the behavior of beams, the bond between concrete and steel, the characteristics of concrete columns with different systems of reinforcements, the use of reinforced concrete culvert pipe, the behavior of reinforced concrete flat slabs and of rigidly connected reinforced concrete frames, and the results of tests on numerous reinforced concrete buildings to determine the stresses under actual loads compared with those originally computed. In addition to the publications devoted to reinforced concrete, there are several dealing with certain properties of crushed stone and with the mortar-making qualities of Illinois sand.

The Station has also contributed a number of important bulletins dealing with the strength of materials. Thus, the bulletin on the strength of chain links, which involved an analytical as well as an experimental investigation, has come to be recognized as authoritative, and the methods for the design of chains therein recommended are now in general use. Investigations of built-up columns, of I-beams, of plate girders, of the effects of repeated stress on the strength of metals, and of the strength and stiffness of steel under biaxial loading may be mentioned as real additions to the knowledge of materials and structures. One of the most interesting of the recent experiments conducted in the Station involved the construction of a microscopic

moving-picture showing the gradual breaking down of the structure of soft iron when subjected to repeated stresses. This unique accomplishment has attracted wide interest among engineers and metallurgists, and it has been suggested that it may lead to a clearer understanding of the behavior of metals when subjected to stresses such as occur in a majority of structures.

One of the most noteworthy investigations of materials has dealt with their magnetic properties as well as their strength. In a series of bulletins, there has been described a new process for the production of iron and iron alloys melted in a vacuum and possessing electrical properties superior to those of iron produced in other ways. The investigation has included tests of a considerable variety of the iron alloys, to determine the adaptability of such materials in the construction of electrical machinery. As a result of these investigations, alloys have been produced on a laboratory scale which have a permeability over five times that possessed by the iron usually employed in the manufacture of electric generators and transformers. It is conceivable that the process for the production of these iron alloys, which has been developed in the laboratories of the Engineering Experiment Station, may lead to the creation of an important industry, for if the process can be developed on a commercial scale, rendering the material readily available for the manufacture of electrical machinery, a great saving in the cost of the construction of such machinery may be effected, since the weight of metal required in such machinery is a function of the permeability.

Various other studies of alloys possessing remarkable qualities have been made by the Engineering Experiment Station and in the Department of Chemistry. One of these alloys, an alloy of nickel, possessing remarkable acid resisting qualities, has been named "Illium" in honor of the State.

Among the most noteworthy contributions of the Engineering Experiment Station are those devoted to the study of fuel, including the mining and preparation of coal, its storage, weathering, spontaneous combustion, and economical use. As a result of certain studies connected with the low temperature distillation of coal, a new process for the manufacture of coke has been discovered, which, if it can be perfected on a commercial scale, may develop a new industry and replace the methods now employed in the coking of coal. This process effects a great reduction in the time required to produce coke, and it renders possible the recovery of by-products which are of greater value than those obtained in the usual processes now employed. If this process finally becomes commercially successful, the importance of the discovery to the industries of America will far outweigh the investment which the State of Illinois has made in the University from its beginning.

In steam engineering some important work has been done in connection with studies of boiler performance and economy and of methods of burning Illinois coal without smoke. Many investigations connected with the generation of power have been made, and the bulletin which deals with the new analysis of the cylinder performance of reciprocating engines represents one of the most important contributions to the science of steam engineering which has ever been made in America.

An important analytical investigation dealing with the properties of saturated and superheated ammonia vapor and the tables computed from the formulas developed by the application of the principles of thermodynamics to the experimental data collected from various sources have been of the utmost importance in the field of mechanical refrigeration, for these tables have enabled refrigerating engineers to make calculations concerning mechanical

refrigeration with greater accuracy than has been heretofore possible. A similar investigation concerning the properties of saturated and superheated steam ranks as one of the most important investigations in this field. Based upon the work of this investigation, there has been computed a set of so-called steam tables which are now in general use in English-speaking countries as a basis for computations connected with the design and performance of steam engineering equipment of all kinds.

One of the most interesting studies presented by the Station has been that made in connection with an effort to correct the acoustical defects of the University Auditorium. After a most elaborate and painstaking investigation, this building has, by rather inexpensive methods, been made very nearly perfect from the standpoint of its acoustics. At the same time the investigation has developed methods for the design of buildings which, if followed, will prevent the construction of buildings in which echoes and reverberations produce serious interference with their use.

The Engineering Experiment Station has long been regarded as a leader in the extension of knowledge of Railway Engineering. Many notable contributions in this field have already been made. Bulletins dealing with the tractive resistance of freight and passenger trains and of electric cars are employed by many of the railroads as a basis for making up tonnage ratings in the make-up of trains and for the maintenance of proper train schedules. Several important investigations connected with locomotive performance, dealing particularly with fuel economy in locomotives, have been made, and they have proved to be of value to the railroads of the country in the preparation of specifications for fuel.

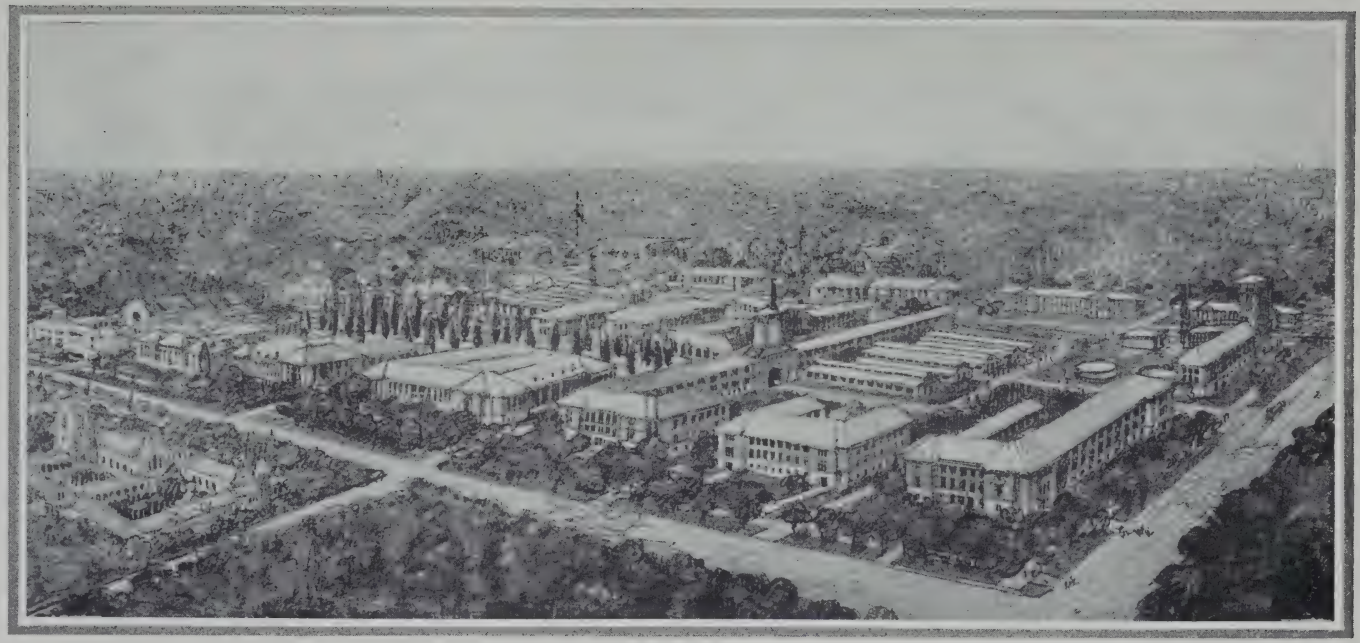
A number of bulletins present the results of interesting

and important investigations of the laws of hydraulics which suggest methods for securing accuracy in the measurement of the flow of water through pipes and in other ways.

During the past year the Station has issued a series of notable circulars in an effort to coöperate with the Government in the dissemination of information concerning the economical use of fuel. One of these circulars discusses problems connected with the economical use of fuel in heating homes; another deals with the use of fuel in stationary hand-fired power plants; a third is devoted to a study of the economical use of fuel in railway locomotives, and a fourth presents in great detail an investigation of the storage of coal. These circulars have been widely distributed, and they have been of great use in the campaign for fuel conservation. The Fuel Conservation Section of the United States Railroad Administration has urged its Regional Directors to order copies of the circular dealing with the use of fuel in railway locomotives, to be supplied to all persons in their employ who have anything to do with the use of fuel.

While in general it has been the policy of the Station to publish bulletins presenting the results of original investigations, it may from time to time present circulars of information compiled from various sources, in an effort to supply information of great importance to the people of the State or of the Nation. The circulars dealing with the economical use of fuel are representative of a kind of service which the Station may render in an emergency.

The conduct of engineering research involves great expense. Many investigations may need to be carried through a period of years before results of significance are obtained. The cost of apparatus and materials and the expense for the salaries of investigators are large. As a consequence, due to the limited budget available for the



A Study for the Extension of the Campus of the College of Engineering, Looking Northwest.
Prepared by the Staff of the Department of Architecture

various activities of the Station, many of the investigations so far undertaken have been selected because they could be completed without involving the expenditure of large sums of money. Many of the most important subjects in which engineers are interested would involve expenditures which are at present far beyond the ability of the Station or the University to meet, however important the results obtained may be. Unquestionably, there must be developed some plan under which the State will subsidize industrial research so that no matter how expensive a particular investigation may be, funds will be available, provided that it seems reasonably certain that the investigation is one which should be undertaken in the interests of the people and of the engineering industries.

The prestige of the Engineering Experiment Station of the University of Illinois has led to a number of requests for engineering research to be conducted in coöperation with industries or groups of industries interested in the solution of important problems. A number of coöperative investigations are already in progress or have been completed under arrangements which provide that the Station will assume the general supervision of the work, furnish such apparatus as it may have at its disposal, and publish the results obtained, while the coöperating agent furnishes the funds for special investigators, materials, and unusual apparatus.

An investigation on stresses in railway track has been in progress for several years under a coöperative arrangement between the Engineering Experiment Station, the American Society of Civil Engineers, and the American Railway Engineering Association. The data so far obtained from this investigation seem to indicate that the results will be of the utmost value in extending our knowledge of track construction and maintenance.

Mention has already been made of the recently discovered process for the coking of coal. This investigation was first undertaken by the Engineering Experiment Station. After it had progressed to a point which indicated that the process had important possibilities, an investigation of the process was undertaken on a very much larger scale in coöperation with A. T. Hert, president of the American Creosoting Company, who furnished a large sum of money to permit the Station to continue its work.

For several years the Station has been conducting an investigation to determine the stresses in chilled car wheels, undertaken in coöperation with the Association of Manufacturers of Chilled Car Wheels, to determine the characteristics of such wheels, with a view to their redesign and to a reduction in their failures in use.

During the past year the Station has conducted a number of significant investigations in coöperation with various government bureaus. In the main the results of these investigations have been regarded as secret because they were undertaken to determine the solution of problems of interest in the prosecution of the war. In this connection it is interesting to note that as a result of tests made in the laboratories of the College of Engineering, certain questions connected with the selection of heating systems for the National Army Cantonments were settled. Other investigations connected with the properties of materials, with the detection of submarines, with the recovery of pyrite which is largely employed in the manufacture of sulphuric acid, and with the development of optical glass have been in progress and some of them have been completed.

Recently the National Warm Air Heating and Ventilating Association, representing some four hundred manufacturers of warm air furnaces, provided the Engineering

Experiment Station with a large sum of money, to be expended in an elaborate investigation of warm air furnaces and furnace heating. This fund was provided solely for scientific research in an effort to advance our knowledge of the art of warm air furnace heating, and in the expectation that improvements in the rating and design of such apparatus would result.

On several occasions the Station has undertaken and completed important investigations of locomotive performance and of train resistance in coöperation with various railroads of the country. With our magnificent Locomotive Laboratory, it has long been hoped that a plan for a consistent series of investigations of locomotive performance may ultimately be worked out in coöperation with the railroads which will be chiefly benefited by the results obtained.

For a considerable number of years the Engineering Experiment Station, in coöperation with the State Geological Survey and the United States Bureau of Mines, has investigated problems of importance to the coal mining interests of Illinois. At the present time these three agencies, in coöperation with representatives from the Illinois Gas Association, have undertaken an investigation to determine the adaptability of Illinois coal in the manufacture of illuminating gas. As a result of restrictions imposed by the United States Fuel Administration, the gas manufacturers of the Central West have found difficulty in securing their usual supply of eastern gas coal. Numerous problems of importance in connection with the adaptation of Illinois coal to this purpose have had to be met, and the agencies mentioned are undertaking the solution of these problems in the interests of the manufacturers of Illinois and adjoining states.

Emphasis should be laid upon the fact that the Engineering Experiment Station has been created for the extension

of our knowledge of the science of engineering for the benefit of all the people. It has never been used as a medium to exploit inventions or to advance the interest of individuals. In its coöperative investigations, the results of these investigations are given freely to the public, even though the expense thereof has been borne by a single individual or corporation, or by an association of industries. The importance of industrial research cannot be overemphasized. The future success of the industries of Illinois and of the Nation depends upon a complete understanding of the scientific principles involved. This will result in true conservation; that is, in the elimination of waste and in increased efficiency in all the important industries.

The following list includes all the circulars and bulletins published by the Engineering Experiment Station up to the present time.

PUBLICATIONS OF

THE ENGINEERING EXPERIMENT STATION

CIRCULARS

1. High-Speed Tool Steels, by L. P. Breckenridge. 1905. *None available.*
2. Drainage of Earth Roads, by Ira O. Baker. 1906. *None available.*
3. Fuel Tests with Illinois Coal (Compiled from tests made by the Technological Branch of the U. S. G. S., at St. Louis, Mo., Fuel Testing Plant. 1904–1907), by L. P. Breckenridge and Paul Diserens. 1908. *Thirty cents.*
4. The Economical Purchase and Use of Coal for Heating Homes with Special Reference to Conditions in Illinois. 1917. *Ten cents.*
5. The Utilization of Pyrite Occurring in Illinois Bituminous Coal, by E. A. Holbrook. 1917. *Free upon request.*
6. The Storage of Bituminous Coal, by H. H. Stoek. 1918. *Forty cents.*
7. Fuel Economy in the Operation of Hand Fired Power Plants. 1918. *Twenty cents.*
8. The Economical Use of Coal in Railway Locomotives. 1918. *Twenty cents.*

BULLETINS

1. Tests of Reinforced Concrete Beams, by Arthur N. Talbot. 1904. *None available.*
2. Tests of High-Speed Tool Steels on Cast Iron, by L. P. Breckenridge and Henry B. Dirks. 1905. *None available.*
3. The Engineering Experiment Station of the University of Illinois, by L. P. Breckenridge. 1906. *None available.*
4. Tests of Reinforced Concrete Beams, Series of 1905, by Arthur N. Talbot. 1906. *Forty-five cents.*
5. Resistance of Tubes to Collapse, by Albert P. Carman and M. L. Carr. 1906. *None available.*
6. Holding Power of Railroad Spikes, by Roy I. Webber. 1906. *None available.*
7. Fuel Tests with Illinois Coals, by L. P. Breckenridge, S. W. Parr, and Henry B. Dirks. 1906. *None available.*
8. Tests of Concrete: I, Shear; II, Bond, by Arthur N. Talbot. 1906. *None available.*
9. An Extension of the Dewey Decimal System of Classification Applied to the Engineering Industries, by L. P. Breckenridge and G. A. Goodenough. 1906. Rev. Ed. 1912. *Fifty cents.*
10. Tests of Concrete and Reinforced Concrete Columns, Series of 1906, by Arthur N. Talbot. 1907. *None available.*
11. Effect of Scale on the Transmission of Heat through Locomotive Boiler Tubes, by Edward C. Schmidt and John M. Snodgrass. 1907. *None available.*
12. Tests of Reinforced Concrete T-Beams, Series of 1906, by Arthur N. Talbot. 1907. *None available.*
13. An Extension of the Dewey System of Classification Applied to Architecture and Building, by N. Clifford Ricker. 1907. *None available.*
14. Tests of Reinforced Concrete Beams, Series of 1906, by Arthur N. Talbot. 1907. *None available.*
15. How to Burn Illinois Coal without Smoke, by L. P. Breckenridge. 1907. *None available.*
16. A Study of Roof Trusses, by N. Clifford Ricker. 1907. *None available.*
17. The Weathering of Coal, by S. W. Parr and N. D. Hamilton. 1907. *None available.*
18. The Strength of Chain Links, by G. A. Goodenough and L. E. Moore. 1907. *Forty cents.*
19. Comparative Tests of Carbon, Metallized Carbon, and Tantalum Filament Lamps, by T. H. Amrine. 1907. *None available.*
20. Tests of Concrete and Reinforced Concrete Columns, Series of 1907, by Arthur N. Talbot. 1907. *None available.*
21. Tests of a Liquid Air Plant, by C. S. Hudson and C. M. Garland. 1908. *Fifteen cents.*
22. Tests of Cast Iron and Reinforced Concrete Culvert Pipe, by Arthur N. Talbot. 1908. *None available.*
23. Voids, Settlement and Weight of Crushed Stone, by Ira O. Baker. 1908. *Fifteen cents.*

24. The Modification of Illinois Coal by Low Temperature Distillation, by S. W. Parr and C. K. Francis. 1908. *Free upon request.*
25. Lighting Country Homes by Private Electric Plants, by T. H. Amrine. 1908. *Twenty cents.*
26. High Steam-Pressures in Locomotive Service (A Review of a Report to the Carnegie Institution of Washington), by W. F. M. Goss. 1908. *Twenty-five cents.*
27. Tests of Brick Columns and Terra Cotta Block Columns, by Arthur N. Talbot and Duff A. Abrams. 1908. *Twenty-five cents.*
28. A Test of Three Large Reinforced Concrete Beams, by Arthur N. Talbot. 1908. *Fifteen cents.*
29. Tests of Reinforced Concrete Beams: Resistance to Web Stresses, Series of 1907 and 1908, by Arthur N. Talbot. 1909. *Forty-five cents.*
30. On the Rate of Formation of Carbon Monoxide in Gas Producers, by J. K. Clement, L. H. Adams, and C. N. Haskins. 1909. *Free upon request.*
31. Fuel Tests with House-Heating Boilers, by J. M. Snodgrass. 1909. *Free upon request.*
32. The Occluded Gases in Coal, by S. W. Parr and Perry Barker. 1909. *Fifteen cents.*
33. Tests of Tungsten Lamps, by T. H. Amrine and A. Guell. 1909. *Twenty cents.*
34. Tests of Two Types of Tile-Roof Furnaces under a Water-Tube Boiler, by J. M. Snodgrass. 1909. *Free upon request.*
35. A Study of Base and Bearing Plates for Columns and Beams, by N. Clifford Ricker. 1909. *Twenty cents.*
36. The Thermal Conductivity of Fire-Clay at High Temperatures, by J. K. Clement and W. L. Egy. 1909. *Twenty cents.*
37. Unit Coal and the Composition of Coal Ash, by S. W. Parr and W. F. Wheeler. 1909. *None available.*
38. The Weathering of Coal, Series of 1909, by S. W. Parr and W. F. Wheeler. 1909. *Free upon request.*
39. Tests of Washed Grades of Illinois Coal, by C. S. McGovney. 1909. *Free upon request.*
40. A Study in Heat Transmission, by J. K. Clement and C. M. Garland. 1909. *Ten cents.*
41. Tests of Timber Beams, by Arthur N. Talbot. 1909. *Thirty-five cents.*
42. The Effect of Keyways on the Strength of Shafts, by Herbert F. Moore. 1909. *Free upon request.*
43. Freight Train Resistance, by Edward C. Schmidt. 1910. *Seventy-five cents.*
44. An Investigation of Built-up Columns under Load, by Arthur N. Talbot and Herbert F. Moore. 1910. *Thirty-five cents.*
45. The Strength of Oxyacetylene Welds in Steel, by Herbert L. Whittemore. 1910. *Free upon request.*
46. The Spontaneous Combustion of Coal, by S. W. Parr and F. W. Kressman. 1910. *Free upon request.*
47. Magnetic Properties of Heusler Alloys, by Edward B. Stephenson. 1910. *Free upon request.*
48. Resistance to Flow through Locomotive Water Columns, by Arthur N. Talbot and Melvin L. Enger. 1911. *Free upon request.*

49. Tests of Nickel-Steel Riveted Joints, by Arthur N. Talbot and Herbert F. Moore. 1911. *Free upon request.*
50. Tests of a Suction Gas Producer, by C. M. Garland and A. P. Kratz. 1911. *Free upon request.*
51. Street Lighting, by J. M. Bryant and H. G. Hake. 1911. *Thirty-five cents.*
52. An Investigation of the Strength of Rolled Zinc, by Herbert F. Moore. 1911. *Free upon request.*
53. Inductance of Coils, by Morgan Brooks and H. M. Turner. 1912. *Free upon request.*
54. Mechanical Stresses in Transmission Lines, by A. Guell. 1912. *Free upon request.*
55. Starting Currents of Transformers, with Special Reference to Transformers with Silicon Steel Cores, by Trygve D. Yensen. 1912. *Free upon request.*
56. Test of Columns: An Investigation of the Value of Concrete as Reinforcement for Structural Steel Columns, by Arthur N. Talbot and Arthur R. Lord. 1912. *Free upon request.*
57. Superheated Steam in Locomotive Service (A Review of Publication No. 127 of the Carnegie Institution of Washington), by W. F. M. Goss. 1912. *Free upon request.*
58. A New Analysis of the Cylinder Performance of Reciprocating Engines, by J. Paul Clayton. 1912. *Free upon request.*
59. The Effects of Cold Weather upon Train Resistance and Tonnage Rating, by Edward C. Schmidt and F. W. Marquis. 1912. *Free upon request.*
60. The Coking of Coal at Low Temperatures (With a Preliminary Study of the By-Products), by S. W. Parr and H. L. Olin. 1912. *Twenty-five cents.*
61. Characteristics and Limitations of the Series Transformer, by A. R. Anderson and H. R. Woodrow. 1912. *Free upon request.*
62. The Electron Theory of Magnetism, by Elmer H. Williams. 1912. *Thirty-five cents.*
63. Entropy-Temperature and Transmission Diagrams for Air, by C. R. Richards. 1913. *Twenty-five cents.*
64. Tests of Reinforced Concrete Buildings under Load, by Arthur N. Talbot and Willis A. Slater. 1913. *Free upon request.*
65. The Steam Consumption of Locomotive Engines from the Indicator Diagrams, by J. Paul Clayton. 1913. *Free upon request.*
66. The Properties of Saturated and Superheated Ammonia Vapor, by G. A. Goodenough and Wm. Earl Mosher. 1913. *Fifty cents.*
67. Reinforced Concrete Wall Footings and Column Footings, by Arthur N. Talbot. 1913. *Fifty cents.*
68. The Strength of I-Beams in Flexure, by Herbert F. Moore. 1913. *Twenty cents.*
69. Coal Washing in Illinois, by F. C. Lincoln. 1913. *Fifty cents.*
70. The Mortar-Making Qualities of Illinois Sands, by C. C. Wiley. 1913. *Twenty cents.*
71. Tests of Bond between Concrete and Steel, by D. A. Abrams. 1913. *One dollar.*
72. Magnetic and Other Properties of Electrolytic Iron Melted in Vacuo, by Trygve D. Yensen. 1914. *Free upon request.*

73. Acoustics of Auditoriums, by F. R. Watson. 1914. *Twenty cents.*
74. The Tractive Resistance of a 28-ton Electric Car, by Harold H. Dunn. 1914. *Free upon request.*
75. Thermal Properties of Steam, by G. A. Goodenough. 1914. *Thirty-five cents.*
76. The Analysis of Coal with Phenol as a Solvent, by S. W. Parr and H. F. Hadley. 1914. *Twenty-five cents.*
77. The Effect of Boron upon the Magnetic and Other Properties of Electrolytic Iron Melted in Vacuo, by Trygve D. Yensen. 1915. *Free upon request.*
78. A Study of Boiler Losses, by A. P. Kratz. 1915. *Free upon request.*
79. The Coking of Coal at Low Temperatures with Special Reference to the Properties and Composition of the Products, by S. W. Parr and H. L. Olin. 1915. *Free upon request.*
80. Wind Stresses in the Steel Frames of Office Buildings, by W. M. Wilson and G. A. Maney. 1915. *Fifty cents.*
81. Influence of Temperature on the Strength of Concrete, by A. B. McDaniel. 1915. *Free upon request.*
82. Laboratory Tests of a Consolidation Locomotive, by E. C. Schmidt, J. M. Snodgrass, and R. B. Keller. 1915. *Sixty-five cents.*
83. Magnetic and Other Properties of Iron-Silicon Alloys, Melted in Vacuo, by Trygve D. Yensen. 1915. *Free upon request.*
84. Tests of Reinforced Concrete Flat Slab Structures, by Arthur N. Talbot and Willis A. Slater. 1916. *Sixty-five cents.*
85. The Strength and Stiffness of Steel under Biaxial Loading, by A. J. Becker. 1916. *Free upon request.*
86. Strength of Webs of I-Beams and Girders, by H. F. Moore and W. M. Wilson. 1916. *Free upon request.*
87. Correction of Echoes and Reverberation in the Auditorium, University of Illinois, by F. R. Watson and J. M. White. 1916. *Free upon request.*
88. Dry Preparation of Bituminous Coal at Illinois Mines, by E. A. Holbrook. 1916. *Seventy cents.*
89. Specific Gravity Studies of Illinois Coal, by M. L. Nebel. 1916. *Free upon request.*
90. Some Graphical Solutions of Electric Railway Problems, by A. M. Buck. 1916. *Free upon request.*
91. Subsidence Resulting from Mining, by L. E. Young and H. H. Stoek. 1916. *None available.*
92. The Tractive Resistance on Curves of a 28-ton Electric Car, by E. C. Schmidt and H. H. Dunn. 1916. *Free upon request.*
93. A Preliminary Study of the Alloys of Chromium, Copper, and Nickel, by D. F. McFarland and O. E. Harder. 1916. *Free upon request.*
94. The Embrittling Action of Sodium Hydroxide on Soft Steel, by S. W. Parr. 1917. *Free upon request.*
95. Magnetic and Other Properties of Iron-Aluminum Alloys Melted in Vacuo, by T. D. Yensen and W. A. Gatward. 1917. *Free upon request.*
96. The Effect of Mouthpieces on the Flow of Water through a Submerged Short Pipe, by Fred B. Seely. 1917. *Free upon request.*
97. Effects of Storage upon the Properties of Coal, by S. W. Parr. 1917. *Free upon request.*

98. Tests of Oxyacetylene Welded Joints in Steel Plates, by Herbert F. Moore. 1917. *Free upon request.*
99. The Collapse of Short Thin Tubes, by A. P. Carman. 1917. *Free upon request.*
100. Percentage of Extraction of Bituminous Coal with Special Reference to Illinois Conditions, by C. M. Young. 1917. *Free upon request.*
101. Comparative Tests of Six Sizes of Illinois Coal on a Mikado Locomotive, by E. C. Schmidt, J. M. Snodgrass, and O. S. Beyer, Jr. 1917. *Free upon request.*
102. A Study of the Heat Transmission of Building Materials, by A. C. Willard and L. C. Lichty. 1917. *Free upon request.*
103. An Investigation of Twist Drills, by B. W. Benedict and W. P. Lukens. 1917. *Free upon request.*
104. Tests to Determine the Rigidity of Riveted Joints of Steel Structures, by W. M. Wilson and H. F. Moore. 1917. *Free upon request.*
105. Hydraulic Experiments with Valves, Orifices, Hose, Nozzles, and Orifice Buckets, by Arthur N. Talbot, F. B. Seely, V. R. Fleming, and M. L. Enger. 1918. *Free upon request.*
106. Test of a Flat Slab Floor of the Western Newspaper Union Building, by Arthur N. Talbot and H. F. Gonnerman. 1918. *Free upon request.*
107. Analysis and Tests of Rigidly Connected Reinforced Concrete Frames, by Mikishi Abe. 1918. *Free upon request.*
108. Analysis of Statically Indeterminate Structures by the Slope Deflection Method, by W. M. Wilson, F. E. Richart, and Camillo Weiss. 1918. *Free upon request.*
109. The Pipe Orifice as a Means of Measuring Flow of Water through a Pipe, by R. E. Davis and H. H. Jordan. 1918. *Free upon request.*
110. Passenger Train Resistance, by E. C. Schmidt and H. H. Dunn. 1918. *Free upon request.*

NEEDS OF THE COLLEGE OF ENGINEERING AND OF THE ENGINEERING EXPERIMENT STATION

The Staff of Instruction.—The physical equipment of a modern College of Engineering should be sufficient to meet fully the existing demands for instruction and research and it should be located in well designed and attractive laboratories. To render such equipment effective, however, it is imperative that the men in charge of instruction be specialists of wide experience and of high ideals. It is only through this combination of men and of equipment that an institution can occupy a commanding position in the field of engineering education.

The requirements of modern engineering education impose unusually exacting qualifications for membership in the teaching staffs of the technical schools. The successful instructor in engineering must have had a thorough educational and professional preparation for his work; he should have had a sufficient amount of practical engineering experience to appreciate fully the problems which his students will encounter after graduation; he must be tactful in his relations with men, and possessed of a personality which will inspire the confidence and enthusiasm of his students; and he must be filled with a desire to extend the knowledge of the subject which he represents, through scientific research and through contributions to its literature. The truly effective college professor has all the characteristics of leadership which are essential to success in business and professional life, in addition to certain qualifications already named, some of which may be of minor importance to success in a business or professional career. The period of apprenticeship through which an instructor must pass before he

can expect to become a professor of engineering is a long one, and when he finally reaches a position of eminence and distinction in his work, he is forced to accept an income which is far below that which may be attained by men of similar accomplishments in business or professional work. As a result of this condition, it is exceedingly difficult to attract the proper kind of young men into academic work, notwithstanding the satisfaction which a teacher enjoys in his contact with young men, and the opportunities for study and research which the college life affords. While it may never be possible for the engineering colleges to compete with the industries for men, it is fundamental to their future success that they be permitted to provide salaries which will render it possible for a college instructor to continue his work without such large sacrifices in earning power as now prevail. A very substantial increase in the salaries paid to college instructors and professors must be made if a high efficiency of instruction in educational institutions is to be maintained. At the present time, because of the tremendous increase in the cost of living, and of little, if any, change in salaries, the purchasing power of a professor's salary has been very greatly decreased.

The College of Engineering of the University of Illinois should be permitted to readjust its scale of salaries so that it may attract the best technical educators to its staff and hold them against the competition of other similar institutions. In the opinion of those responsible for the development of the College of Engineering, the salary scale should be promptly readjusted to the following basis:

	YEARLY
Heads of Departments	$5,000 to $6,000
Professors, not Heads of Departments	3,500 " 5,000
Associate Professors	3,000 " 3,500
Assistant Professors	2,500 " 3,000

	YEARLY
Associates	$2,000 to $2,500
Instructors	1,500 " 1,800
Full-time Assistants	1,000 " 1,500
Half-time Assistants	600 " 750

In order that the College of Engineering may keep pace with the rapid advance in engineering science, and that it may respond to the industrial needs of the State, it is imperative that it be prepared to add to its staff, from time to time, men who are recognized as leaders in their respective fields. As a result of the war, the number of men in the staff of the College has been seriously reduced. Its faculty must be increased as rapidly as suitable men can be found to fill the vacancies which now exist, and it must be prepared to add a considerable number of new professors and instructors who are specialists in phases of engineering as yet undeveloped in this institution. It seems inevitable that the enrolment in the College of Engineering will increase during the next few years, so that substantial additions to the salary budget for this College will be necessary to provide for the instruction of increasing numbers of students.

This problem of staff organization and development is doubtless the most important one with which the officers of the College of Engineering have to deal. The University and the people of the State must recognize the increasing difficulty in securing instructors of the type herein specified, and they must be prepared to coöperate in the effort to maintain a faculty comparable with those in the best technical schools of the world. Unless this is done, the standing of this institution cannot be maintained.

The Maintenance and Extension of Equipment.—During recent years there has been little change in the appropriations for current expenses and for the maintenance and

The Mining Engineering Laboratory, with a Sketch of the Proposed Addition

extension of equipment in the College of Engineering. There has been a considerable decrease this year in the appropriation for this purpose. The cost of materials, supplies and equipment needed for instruction has very greatly increased within the last few years, and it is unlikely that there will be any marked decrease in the cost of such commodities for some time. Assuming that the enrolment in the College will increase beyond that which prevailed prior to the war, it will be essential that additional funds be provided for this purpose during the coming biennium.

In addition to the funds for materials, supplies and the maintenance of existing equipment, it is imperative that there be provided annually an adequate fund for the purchase of new equipment and for the replacement of obsolete apparatus. The astonishing development which has taken place in engineering science during recent years has rendered it desirable that the College replace much of its antiquated equipment with modern apparatus, so that the student may become familiar with the latest developments in every branch of engineering. No industrial organization can afford to use equipment which has been rendered obsolete by the development of new processes and apparatus, and no college of engineering should be expected to use antiquated equipment for the instruction of men who will later be in responsible charge of the industries of the country.

The Engineering Experiment Station.—At the present time the appropriations for salaries, for expenses connected with investigations and for the publication and distribution of bulletins of the Engineering Experiment Station are insufficient to meet the reasonable desires of the Executive Staff. Each department in the College should be provided with one or more full-time research assistants, and there

should be an increased number of Research Graduate Assistants available for those departments which can use them effectively. The obligations of the members of the teaching staff of the College to their students prevent their doing much significant research work without assistance. Where members of the teaching staff need such assistance, the Station should be prepared to provide for this need. Additional funds for salaries in the Engineering Experiment Station are necessary to enable it to fulfill its obligations to stimulate and promote research.

In addition to an adequate scientific staff, the Station must be prepared to provide the varied equipment essential to the successful prosecution of every investigation which is undertaken. Up to the present time it has been necessary to plan a program of investigations which involve a minimum of expense. Many desirable and important investigations should be undertaken when adequate funds are available. It is hoped that the importance of research will justify a substantial increase in the appropriations for such work.

A considerable proportion of the money appropriated to the Engineering Experiment Station is required for the printing and distribution of bulletins and circulars. It is obvious that the research work of the Station would be useless, unless the results are made available to every one interested. The work of the Engineering Experiment Station, which has already been completed, is sufficient evidence of the importance of the Station to the State, and it should be sufficient justification for more generous support of this institution in the future.

Buildings and Land.—With the exception of the Departments of Physics, Railway Engineering and Ceramic Engineering, there are no other departments in the College

of Engineering which have adequate facilities either in buildings or equipment. In some of the older departments of the College, the need for additional room is so serious that their work is greatly handicapped, and it is difficult for them to meet the changing conditions and needs of engineering education and engineering research. Few of the buildings occupied by the College of Engineering are of permanent character, and the most of them are poorly adapted to the work for which they are used. In the erection of the older buildings of the engineering group, no attempt was made to secure architectural harmony, and there seems to have been no definite scheme of campus development. Many of the buildings have been outgrown, and apparently few of them were designed with much reference to the needs of the departments which they house.

The successful future development of the College of Engineering depends to a very large extent upon the erection of a group of buildings to house the various departments, which are designed so that each building becomes a part of a properly conceived scheme of laboratories, drafting rooms, museums, class-rooms and offices, arranged to allow for future growth that will be rendered necessary by an increased student enrolment and by the necessities of a changing engineering practice. As the engineering group is developed, it should conform to some harmonious architectural plan which will insure that buildings will be erected in proper relation to each other, and with due regard for landscape effects in order to produce the impression of beauty and adaptability so desirable in college architecture.

Studies for the development of the campus of the College of Engineering have been prepared by the staff of the Department of Architecture, and the accompanying

illustrations present perspective views of the group of engineering buildings which may ultimately be necessary to provide for the needs of the College. Estimates concerning the space requirements for the departments now represented in the College indicate the need for additional major buildings of the class-room type having a gross floor area of 465,600 square feet, together with buildings of the laboratory type having a gross floor area of 452,900 square feet. The estimated cost of the former type of buildings is $3,146,000, and of the latter type is $1,695,000.

In the consideration of plans for the enlargement of the College of Engineering, it has been definitely agreed that the campus should be extended to the eastward from the buildings already erected. In order that this plan may be realized, it will be necessary for the University to purchase a considerable quantity of city property. Much of this property is improved, and consequently its cost will be large. Estimates have been made that the total cost of the land which the University must ultimately acquire to meet the needs of the College of Engineering will be $270,000.

The budget presented for the consideration of the President and of the Board of Trustees provides for the completion of a number of minor building projects, including an addition to the Transportation Building, the erection of a wing to the Mining Laboratory, and a Railway Electrical Laboratory. In addition to these building projects, which should take precedence over other construction work, the officers of the College of Engineering consider it essential that provision be made as soon as possible for a building to house the Department of Architecture and such of the Fine Arts as may ultimately be developed in the University; a building to provide for the needs of the Departments of Mining Engineering, Metallurgical

THE LOCOMOTIVE LABORATORY WITH A SKETCH OF THE RAILWAY ELECTRICAL LABORATORY, THE ERECTION OF WHICH IS RECOMMENDED

Engineering and Chemical Engineering; a building to house the Departments of Electrical Engineering and Mechanical Engineering; a building to provide for the Departments of Theoretical and Applied Mechanics, Municipal and Sanitary Engineering and Civil Engineering; a building to house the Shop Laboratories; and a building to provide for instruction and research in Hydraulic Engineering. In some one of these major buildings, or perhaps preferably in a separate building, provision should be made for a great Engineering Museum, in which there can be brought together a comprehensive exhibit of machines and processes. The educational value of such a museum cannot be overemphasized in a country which has done so much in invention and in the development of industrial processes.

If the changing and constantly increasing needs of the College of Engineering are to be properly met, it is important that some definite continuing program be approved for the construction of buildings for its use, and that funds be provided to render it possible to proceed with the erection of a dignified, harmonious group of buildings such as is herein proposed.

Summer Surveying Camp.—When instruction in engineering was first undertaken by the colleges, comparatively little progress had been made in its development as a science. The employers of graduates of engineering schools demanded that these men be prepared to engage in practical work, and consequently the curriculums offered by the colleges included a large amount of time devoted to such practical subjects as surveying, shop work, drafting, etc. During recent years the more exacting requirements for extended theoretical and scientific knowledge in engineering have rendered it necessary to increase the time devoted to the study of the mathematical, physical, and applied

sciences, and as a consequence the time for the so-called practical subjects has been reduced. To meet these changing conditions and at the same time to retain in the curriculum as much as possible of the practical work, a considerable number of the institutions of the country require their students to do some kind of summer work. Nearly all the leading technical schools in America now require some summer instruction in surveying, and many of them have more or less elaborate summer camps for instruction in this subject and in other related engineering work.

The College of Engineering of the University of Illinois needs to provide for more instruction in surveying and map-making. The location of the University is not such as to permit instruction and practice in topographic, hydrographic, mine and railway surveying, and conditions are not favorable for instruction in simple plane surveying. It is important, therefore, that this institution adopt the plan for a summer camp, which has been found successful in other colleges. In such a camp the students may receive proper instruction in surveying, under conditions which closely approximate those in practical engineering work.

Since a summer surveying camp should be located on a large tract of land of varied topography, with streams or lakes to enable hydrographic surveying to be undertaken, it is recommended that the University acquire a tract of 2,000 or 3,000 acres of land in Northern Michigan or Northern Wisconsin, which may be obtained for a relatively small sum per acre and which will provide for our needs in this connection. A tract in either of these states will afford climatic conditions favorable to outside work. It would be necessary to erect on this land a few simple buildings to be used as mess halls and for purposes of study. For a time at least, it is probable that the students would be quartered in tents.

THE PROPOSED BUDGET FOR THE COLLEGE OF ENGINEERING AND THE ENGINEERING EXPERIMENT STATION FOR THE BIENNIUM BEGINNING JULY 1, 1919

AFTER careful consideration of the needs of the College of Engineering and the Engineering Experiment Station, the Dean and Heads of Departments have submitted a budget for the consideration of the President and the Board of Trustees of the University of Illinois, which is herewith presented.

It was proposed that salaries be readjusted in accordance with the schedule presented in the preceding section of this report, and that provision be made for such new members of the staff as may be necessary to provide for the instruction of students during the coming biennium, or for the development of new work which should be undertaken during this period. In addition to the items for salaries and for the purchase of materials, supplies, equipment, etc., there is included an item for the purchase of land necessary for the future development of a proper building program for the College of Engineering, and another item for the purchase of land to provide facilities for a Summer Surveying Camp.

It is considered essential that during the coming biennium, funds be provided for the completion of the Transportation Building, for an addition to the Mining Laboratory, for the erection of a Railway Electrical Laboratory, and for a small addition to the Machine Shop to serve as a demonstration room for the instruction of students in machine shop practice and management. In addition to these minor structures, it is considered desirable by those responsible for the development of the College of

Engineering that an appropriation be made for the erection of a building to provide adequate facilities for the Departments of Theoretical and Applied Mechanics, Municipal and Sanitary Engineering and Civil Engineering; for a building for the Department of Architecture; and for a building to house the various Shop Laboratories.

BUDGET ESTIMATES FOR THE
COLLEGE OF ENGINEERING AND ENGINEERING EXPERIMENT STATION
FOR THE BIENNIUM BEGINNING JULY 1, 1919
SUBMITTED FOR THE CONSIDERATION OF THE
PRESIDENT AND BOARD OF TRUSTEES OF THE UNIVERSITY OF ILLINOIS

ITEM	For the Year 1919–1920	For the Year 1920–1921	For the Biennum 1919–1921
SALARIES			
College of Engineering	$411,740	$469,960	$ 881,700
Engineering Experiment Station	77,450	85,030	162,480
Coal Mining Investigations	3,400	3,600	7,000
Totals	$492,590	$558,590	$1,051,180
EXPENSES			
College of Engineering	$ 75,000	$ 75,000	$150,000
Engineering Experiment Station	25,000	25,000	50,000
Coal Mining Investigations	1,800	1,800	3,600
Totals	$101,800	$101,800	$203,600
LAND			
Land for the Development of the College of Engineering	$135,000	$ 135,000	$270,000
Land for a Summer Surveying Camp	30,000		30,000
Totals	$165,000	$135,000	$300,000
BUILDINGS			
Completion of Transportation Building	$ 45,000		$ 45,000
Addition to Mining Laboratory	25,000		25,000
Railway Electrical Laboratory	35,000		35,000
Addition to Machine Shop	2,500		2,500
Building for Departments of Theoretical and Applied Mechanics, Municipal and Sanitary Engineering and Civil Engineering	25,000	$275,000	300,000
Building for Department of Architecture	25,000	275,000	300,000
Building for Shop Laboratories		150,000	150,000
Totals	$157,500	$700,000	$857,500
Grand Totals	$916,890	$1,495,390	$2,412,280